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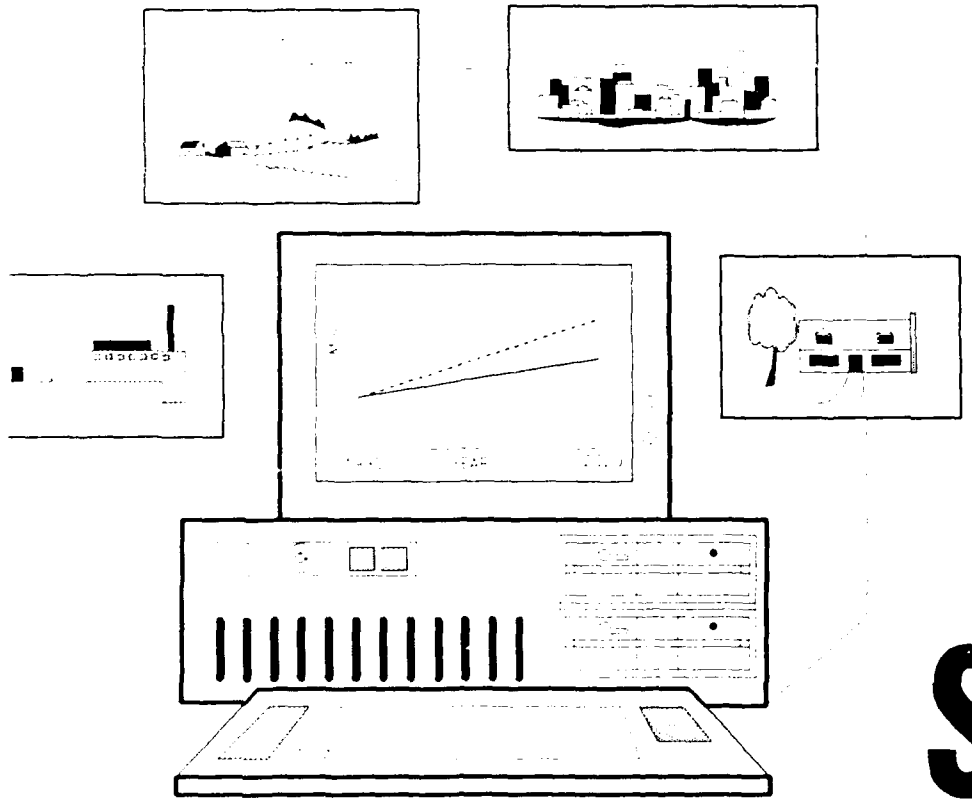
IWR-MAIN WATER USE FORECASTING SYSTEM VERSION 5.1



USER'S MANUAL AND SYSTEM DESCRIPTION

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The IWR-MAIN Water Use Forecasting System is a sophisticated and flexible computer program designed for estimating and forecasting municipal water requirements. The IWR-MAIN System is sectorally, spatially, and seasonally disaggregate. Water requirements are estimated separately for the residential, commercial/institutional, industrial, and public/unaccounted sectors of the study area. Within these major sectors, water use estimates are further disaggregated into individual categories such as metered and sewered residences, commercial establishments, and three-digit SIC manufacturing categories. Definition of the study area as a city, county, or water utility service area provides for spatial disaggregation. Additionally, IWR-MAIN forecasts are presented as summer daily water use, winter daily water use, average daily water use, and maximum-day summer water use. THE IWR-MAIN System can also produce water use forecasts which take into account long-term impacts of demand management or conservation practices that may be or have been implemented in the study area. Keywords: Water conservation; Water conservation; Residential sectors; Industrial areas; Commercial areas;

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IWR-MAIN WATER USE FORECASTING SYSTEM, VERSION 5.1: USER'S MANUAL AND SYSTEM DESCRIPTION

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PREFACE

The municipal water industry faces massive capital investment needs in order to maintain existing and future supplies as well as to maintain the water supply infrastructure. For effective water system planning, these needs must be assessed realistically taking into consideration the potential variability of water use. Understanding and managing water use can result in substantial savings in capital investments in the long run. One way to realize these savings is from precise estimates of future water demand.

The IWR-MAIN Water Use Forecasting System is a sophisticated and flexible computer program designed for estimating and forecasting municipal water requirements. The IWR-MAIN System produces water use forecasts that are sectorally, spatially, and seasonally disaggregate. Water requirements are estimated separately for the residential, commercial/institutional, industrial, and public/unaccounted sectors of the study area. Within these major sectors, water use estimates are further disaggregated into individual categories such as metered and sewered residences, commercial establishments, and three-digit SIC manufacturing categories. Definition of the study area as a city, county, or water utility service area provides for spatial disaggregation. Additionally, IWR-MAIN forecasts are presented as summer daily water use, winter daily water use, average daily water use, and maximum-day summer water use. The IWR-MAIN System can also produce water use forecasts which take into account long-term impacts of demand management or conservation practices that may be or have been implemented in the study area. It is only through these highly disaggregated demand forecasts that patterns and trends of water use and the potential of water conservation measures can be clearly demonstrated.

The results produced by the IWR-MAIN System can provide water planners and water supply agencies with data which may be used to:

(1) plan for the expansion of system capacity (sources, transmission, treatment);

(2) size and expand the distribution systems (network design problems);

(3) prepare contingency plans for water shortages caused by droughts or source contamination;

(4) evaluate the effectiveness (or water savings) of alternative conservation measures;

(5) perform sensitivity analyses with varying assumptions about the prices of water, weather conditions, and other determinants of water use; and

(6) assess utility revenues with improved precision.

Therefore, reliable forecasts of water demand are essential for these water planning needs and water policy decisions.

This manual is designed to allow the user complete flexibility in using the IWR-MAIN System. The input of available socioeconomic data will determine the sectoral disaggregation of the IWR-MAIN System water use forecasts. Furthermore, the availability of disaggregated information concerning existing urban water use increases the potential for calibrating the forecast models to local area conditions and, therefore, improves the accuracy of the forecasts. The user is strongly encouraged to spend considerable effort to obtain the most accurate forecast as possible and to effectively evaluate the potential reduction available from water conservation measures.

The IWR-MAIN System is presented in two major parts.

Part I (User's Manual) contains a simplified example to illustrate how to use and understand the workings of the IWR-MAIN System. The user is presented with each of the available menus and data entry screens. A brief description of the input data is also provided with each data entry screen.

Part II (System Description and Procedures) presents detailed information concerning the IWR-MAIN System for the more analytical user. Data characteristics and sources, computational procedures and equations, and water demand forecasting concepts are discussed. Part II also gives the user information about verification and calibration procedures in order to produce more accurate forecasts.

In addition, there are four appendixes which include an example application, the historical development, utility programs, and technical aspects of the IWR-MAIN System.

Version 5.1 of the IWR-MAIN System as described in this document includes a number of modifications and improvements from version 5.0. Modifications include the expansion of the external projection Data Entry screens, revised commercial and industrial water use coefficients, a commercial and industrial price adjustment option, a residential metered and sewered sector calibration option, a modified report format for the residential sector output, the reporting of water conservation effectiveness by individual measure, a faster Print/View procedure, and two new utilities.

ACKNOWLEDGEMENTS

The completion of this manual was possible thanks to the valuable input and support from the Institute for Water Resources, particularly Mike Krouse, Contracting Officer, and Darrell Nolton.

Also, a substantial contribution to the final report was made by James Crews, Chief of Operations Branch, U.S. Army Corps of Engineers, whose numerous suggestions and thorough review improved the quality of the manual.

Finally, many aspects of the production of this manual would have been impossible without the hard work and capable support of the following team members of Planning and Management Consultants, Ltd.:

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IWR-MAIN WATER USE FORECASTING SYSTEM

PART I

USER'S MANUAL

1. INTRODUCTION

The IWR-MAIN Water Use Forecasting System is a computerized planning tool for estimating current and future water requirements. This User's Manual is designed to provide a guide to the use of the IWR-MAIN System for individuals with minimal computer experience. The guide follows a step-by-step format and includes the basic operational procedures regarding the installation and implementation of the IWR-MAIN System.

Chapter 2 provides you (the user) with the hardware requirements and assistance in "getting started" with the operation of the program. Chapter 3 guides you through the data entry and update procedures using the IWR-MAIN data screens. Chapters 4 through 7 describe the other procedures and operations of the IWR-MAIN System. All available menu screens and data entry screens are included. The data entry screens are shown with sample data to help illustrate the data format.

Chapter 8 is a guide of minimum data requirements for the first-time user. A procedure is provided to familiarize the user with the data entry process and the successful generation of a water use forecast. The minimum data required in each data entry screen for a successful forecast are provided in the tables of Chapter 8. Chapter 9 is a quick reference of key elements described in Part I, the User's Manual.

2. GETTING STARTED

2.1 HARDWARE REQUIREMENTS

The IWR-MAIN System is designed to be used with IBM PC/XT/AT or compatible microcomputer. The minimum hardware requirements for the microcomputer are:

- Two floppy drives (if using a PC system)
- One floppy drive and hard drive (if using an XT/AT system)
- At least 320K of random access memory
- A monochrome or color monitor with graphics card adaptor
- A printer port (if using a printer)
- DOS Version 2.0 or higher

2.2 SOFTWARE SETUP

The IWR-MAIN System is contained on six diskettes:

Diskette #1: Includes the data entry and print/view procedures and one of the IWR-MAIN libraries.
Diskette #2: Includes the edit/validate procedures and two IWR-MAIN libraries.
Diskette #3: Includes the IWR-MAIN run model procedure.
Diskette #4: Includes one of the IWR-MAIN libraries and sufficient free bytes for the temporary file PROJD.
Diskette #5: Contains the External Projection Module utility and its data.
Diskette #6: Contains a utility for updating data files from previous IWR-MAIN versions and a utility for generating a data file from a .DAT file. For a complete discussion of all utilities, see Appendix C.

Backup copies should be made of the six IWR-MAIN program diskettes. To do so, insert an IWR-MAIN diskette into drive A and a formatted blank diskette into drive B and type:

copy a:*.* b:

where a: and b: are drive specifications. Store the originals in a cool, dry place.

Configuring the Disk Operating System (DOS) Diskette

Before using the IWR-MAIN System, your current version of DOS must be modified to include a special IWR-MAIN configuration. Do <u>not</u> modify your original DOS diskette; rather, make the modification on a backup copy of DOS.

Included on IWR-MAIN Diskette #1 is a configuration file labeled CONFIG.SYS. This CONFIG.SYS file allows IWR-MAIN to use the graphic capability of the monitor display, assigns the proper files for opening, and increases the buffer size to 20.

To modify your DOS version, first make a copy of your DOS diskette. Insert your DOS diskette in drive A and a formatted blank diskette in drive B and type:

diskcopy a: b:

Then insert the IWR-MAIN Diskette #1 in drive A and copy the CONFIG.SYS file to your new DOS diskette:

copy a:CONFIG.SYS b:

If a CONFIG.SYS file already exists on your DOS, modify the file using a text editor to include the following (order is not important):

```
device = ANSI.SYS
buffer = 20
files  = 15
```

Note that an ANSI.SYS file must be located on the DOS version you are modifying. The special configuration should not affect other programs or your DOS operation.

In systems without a hard disk, this modified DOS diskette must be "booted" first before using the IWR-MAIN System. Just insert the system diskette in drive A and "reboot" the computer (**press CTRL, ALT, and DEL** at the same time). After entering in the date and time, **press return** to get the familiar A> prompt. Insert IWR-MAIN Diskette #1 in drive A and a clean data diskette in drive B.

The IWR-MAIN System may be accessed from Diskette #1, 2, or 3. At various stages during the use of IWR-MAIN, you will be prompted to switch IWR-MAIN diskettes in drive A.

2.3 INSTALLATION ON HARD DRIVE SYSTEM

The most effective way to use IWR-MAIN is to install it on a hard (fixed) drive. You should fully understand directories and pathing before loading anything onto a hard drive (see DOS manual).

Included on IWR-MAIN Diskette #1 is an "install" program which when activated will systematically load all IWR-MAIN files from the six program diskettes onto your hard disk. It will first create a subdirectory called MAIN51 and then copy all the files from Diskette #1 through Diskette #6 to this subdirectory. To activate the "install" program, insert the IWR-MAIN Diskette #1 in drive A. You must change drives if you are already in drive C by **typing A:**. Now **type INSTALL and press RETURN**. The install program will prompt you when to switch diskettes.

After all files have been successfully copied onto your hard disk, the "install" program will take you back to the "root" directory. These IWR-MAIN files use up an estimated 1.3 megabytes of hard disk memory. Now **type TYPE CONFIG.SYS and press RETURN**. This will display your CONFIG.SYS file. If the three configurations shown above in section 2.2 are not included in your CONFIG.SYS file, edit your file accordingly.

The ANSI.SYS file (from the DOS version which "boots" your hard drive) must be on the "root" directory. If not, copy ANSI.SYS from your DOS diskette onto the "root" directory. Now you should have three key files on your "root" directory which will be activated every time you "boot" or turn on the computer:

COMMAND.COM (from your DOS version)
ANSI.SYS (from your DOS version)
CONFIG.SYS (from IWR-MAIN Diskette #1 or your previously existing file)

It is extremely <u>important</u> that the ANSI.SYS file be from the same version of DOS as the COMMAND.COM file which is located in the "root" directory.

You have the option of using the MAIN51 subdirectory for saving/retrieving your data files as well as saving them on floppy diskettes. The advantages of saving data files on the hard drive are faster access and run time and increased storage capabilities.

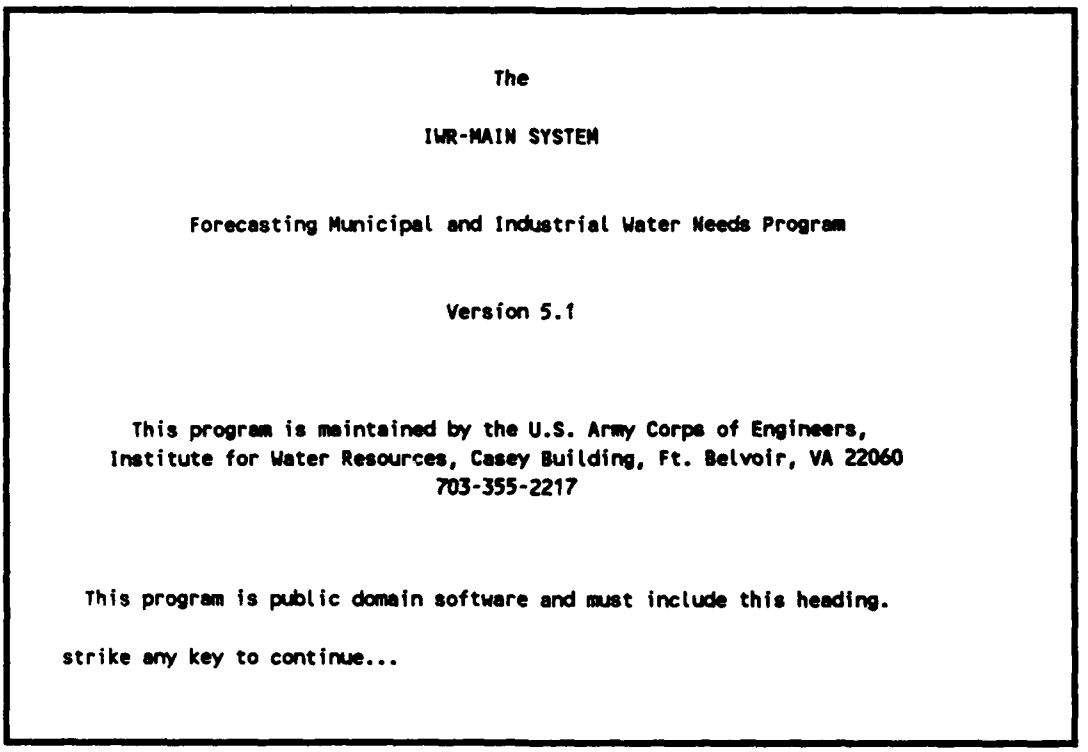
Note that IWR-MAIN during its program run may create more than eight data files (the size of each file will be determined by the amount of data and number of forecast years). Since the standard double-sided, double-density floppy diskette holds approximately 360K of memory bytes, large files may not fit on the floppy. At this time, there is no provision in IWR-MAIN to allow data diskettes to be switched, and thus the program run will be terminated prematurely upon the full use of memory space on the data diskette. Therefore, it may be necessary to store the data files in the hard drive or on a high-density diskette (if a 1.2 megabyte floppy drive is available).

2.4 ACCESSING IWR-MAIN: THE SYSTEM MENU

To run IWR-MAIN, first access the appropriate IWR-MAIN directory or diskette and then follow these instructions:

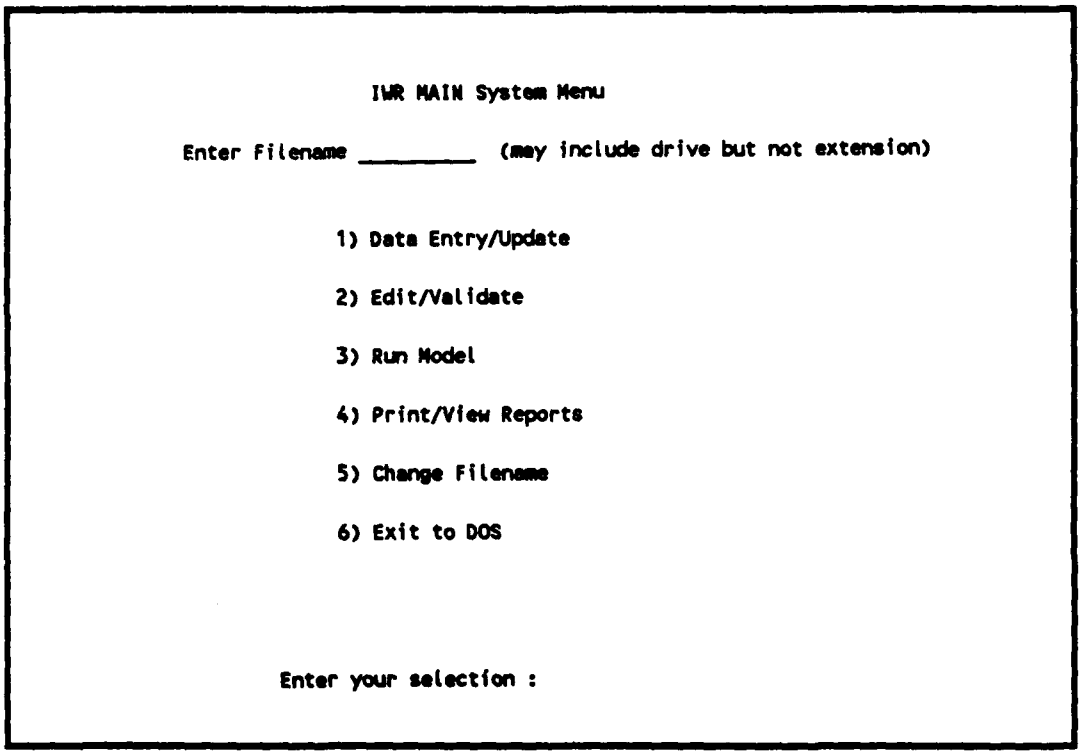
Type IWRMAIN
Press RETURN

The IWR-MAIN Identification Screen appears:



Press any key

The IWR-MAIN System Menu will appear:



There are six procedures available on the System Menu Screen; each will be discussed in detail in the following chapters. To start using IWR-MAIN, type in a filename (up to eight characters long with no punctuation) without an extension. If the drive for your data diskette is different from the program drive, you must include a drive specification.

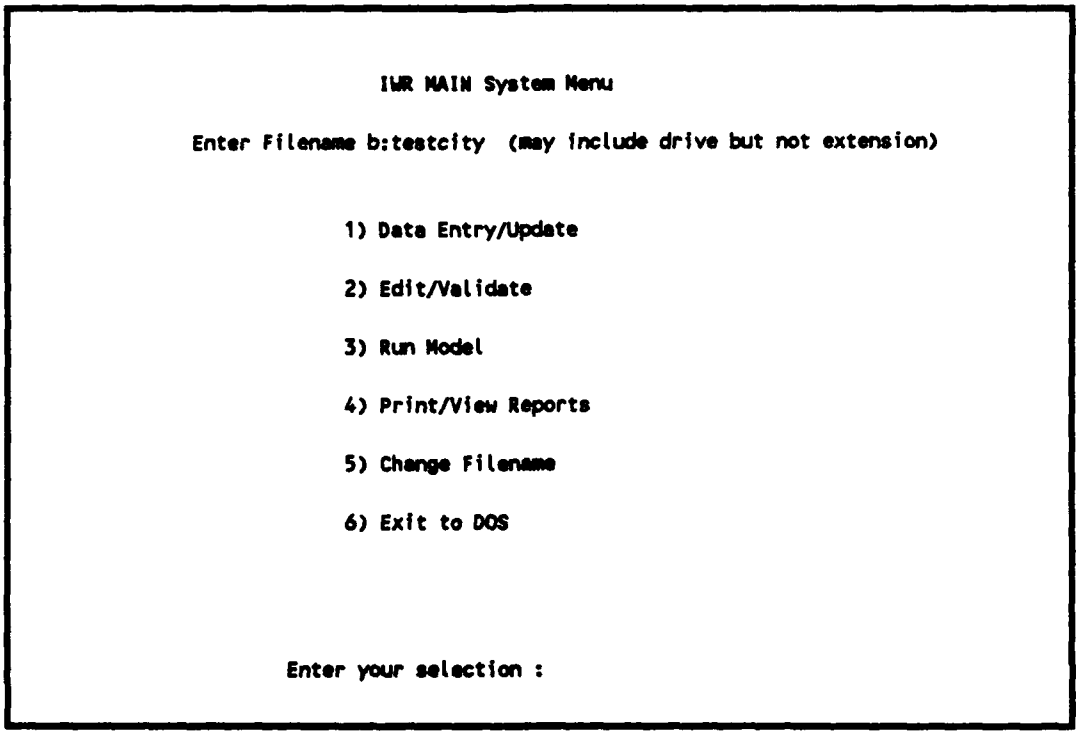
For example:

testcity or **b:testcity**

After typing in a filename, **press RETURN**. To change the filename, select procedure #5 (change filename) and then **retype** the name.

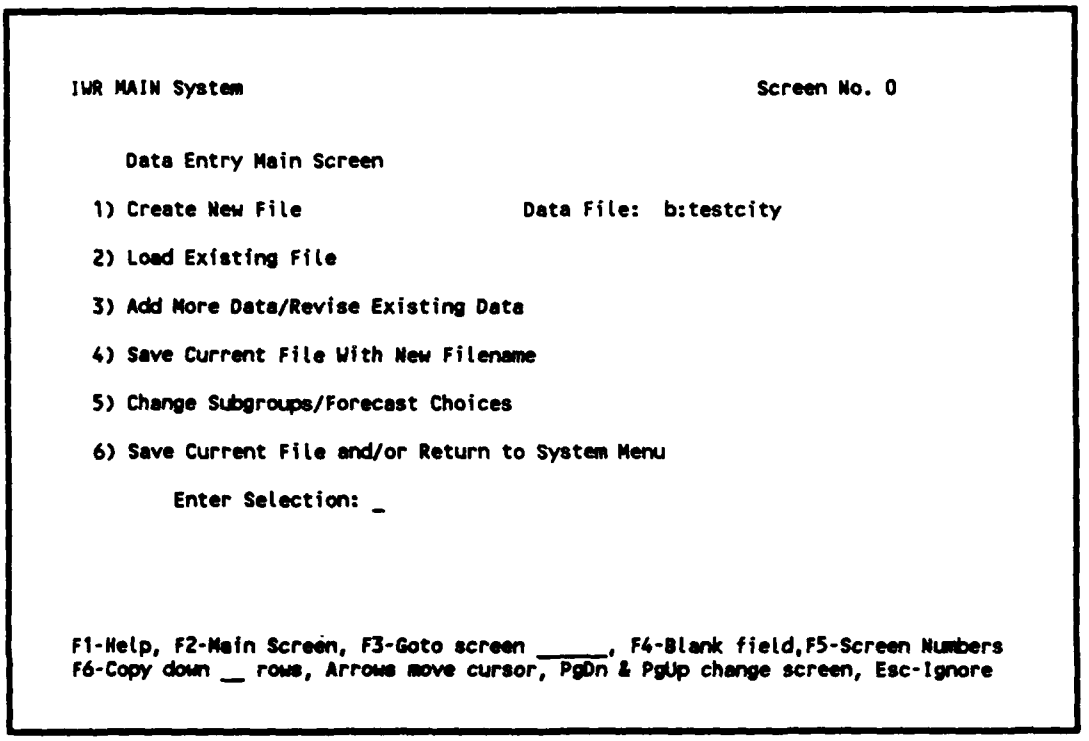
3. DATA ENTRY/UPDATE PROCEDURE

3.1 INTRODUCTION TO DATA ENTRY/UPDATE



The process for inputting data into the IWR-MAIN System is through a detailed series of screens. Using the cursor and function keys, you can manipulate screens and enter data.

Select procedure #1 (Data Entry/Update) on the System Menu (you do not need to press return). The Data Entry Main Screen (screen #0), which allows the selection of the following six options, will appear:



The specified filename will appear in the upper right corner, and the function key descriptions will appear at the bottom of the screen. One of the six options may be selected by entering the appropriate option number; it is not necessary to press the return key. The following briefly describes each option as well as the function keys.

Create New File (Option #1)

Select this option to create a new data file. This option invokes the Parameter Control Screen that prompts you as to which water use categories are to be considered and which types of forecast techniques are to be used. Based on the selection of water use sectors, forecast year(s), and forecast type(s), the page down (PgDn) key will move you through the selected Data Entry screens.

If preceeded by the Load Existing File option, then this option will provide access to the Parameter Control Screen of the loaded data file. In this case, the Create New File option functions the same as the Change Subgroups/Forecast Choices option.

Load Existing File (Option #2)

The selection of this option will allow you to access previously created data files. The filename of the existing data file should have been specified previously on the IWR-MAIN System Menu. This procedure will load the existing data file into the program memory. Once the file is loaded, use either Option #1, 3, or 5 to edit the data.

If you have data files which were created with either IWR-MAIN version 4.0 or 5.0, see Appendix C for directions on using the utility which will convert your old data file to the new version 5.1 data file format.

Add More Data/Revise Existing Data (Option #3)

Subsequent to loading an existing data file, the selection of this option will allow you either to revise existing data or to add new data. This option may also be used to review a data file. The first screen to appear after

the selection of this option is the Municipal Base Year Data Screen (1.1). Any modification of existing data must be saved for subsequent uses.

Save Current File with New Filename (Option #4)

This option allows you to save the contents of the current data file under a different filename. You will be prompted to enter in the new filename after which the program will check for other files with this same name. If another file is found with the same filename as that which you entered, you will be asked if you wish to overwrite the contents of that file with the contents of the file currently in the IWR-MAIN System. If you do not wish to overwrite that existing file, type "N" (no). You will then be asked if you wish to return to the IWR-MAIN System Menu. Enter "N" (no) if you wish to stay in the current Data Entry Main Screen (Screen No. 0). If the new filename which you specify is unique, or if you respond "Y" (yes) to the existing file overwrite prompt, the program will save the current file under the new filename and ask if you wish to return to the IWR-MAIN System Menu.

With this option, you can load and modify an existing data file and save the modified file under a different name, thus preserving your original data file. Also, if you wish to save any changes to your original file, you may do so using option #6. If you wish to generate a forecast with your new data file, return to the system menu and change filename using procedure #5 of that menu.

Change Subgroups/Forecast Choices (Option #5)

The "Change Subgroup/Forecast Choices" option provides access to the Parameter Control Screen. If an existing data file is loaded, this option can be used to modify the selection of water use sectors, conservation subroutine, forecast year(s), and forecast type(s). Note that any change in water use sectors or forecast choices may require appropriate data modifications or additions. Changes to existing data in the Parameter Control Screen and subsequent Data Entry screens should be saved for subsequent uses using option #6. From the Parameter Control Screen, the page down (PgDn) key allows you to access the appropriate Data Entry screens.

Save Current File and/or Return to System Menu (Option #6)

This option will ask if you wish to save the current file. Enter "Y" (yes) if you wish to do so. The program will search for the existence of a file with the same name, and if found, you will be asked if you wish to overwrite the contents of that file with the contents of the file currently in the IWR-MAIN System. If you do not wish to overwrite the existing file, type "N" (no). You will then be asked if you wish to return to the IWR-MAIN System Menu. Enter "N" (no) if you wish to stay in the current Data Entry Main Screen (Screen No. 0). If your current file is new, or if you respond "Y" (yes) to the existing file overwrite prompt, the program will save the current file and then ask if you wish to return to the IWR-MAIN System Menu. If you enter "N" (no) to the first prompt "Do you want to save file?" then you will be asked if you wish to return to the IWR-MAIN System Menu.

Function Keys

F1 - This key will access the on-line help facility. It will change as the screens change (although not all screens have corresponding help statements). There may be more than one screen of the help text, in which case the page down (PgDn) key will scroll the text of the help file.

F2 - This key will take you back to the Data Entry Main Screen. Use the F2 key and then option #6 (or option #4) of the Data Entry Main Screen to end a data entry session.

F3 - This key will take you to any selected screen by typing in the screen number.

F4 - This key will blank the field of entry on which the cursor is located. Do not attempt to blank a field by entering "....." or by using the space key as these will cause errors during the model run.

F5 - This key will bring up the screen index and give an option to go to a specified screen.

F6 - This key has two functions. In the first set of screens (1.1 - 14.x.9), it will act as a copy down function. In the second set of screens (15.1 - 17.x), it will copy values and underscores from previous screens.

Other Keys

- The arrow (cursor) keys move the cursor mark through the screen.
- The PgUp and PgDn keys scroll the screens up or down.
- The ESC key will ignore the last selection or entry you made (works only on screens 1.1 - 14.x.9).
- The backspace key has limited use; when it is not allowed to function, a "beep" will sound, otherwise it deletes the last character typed.

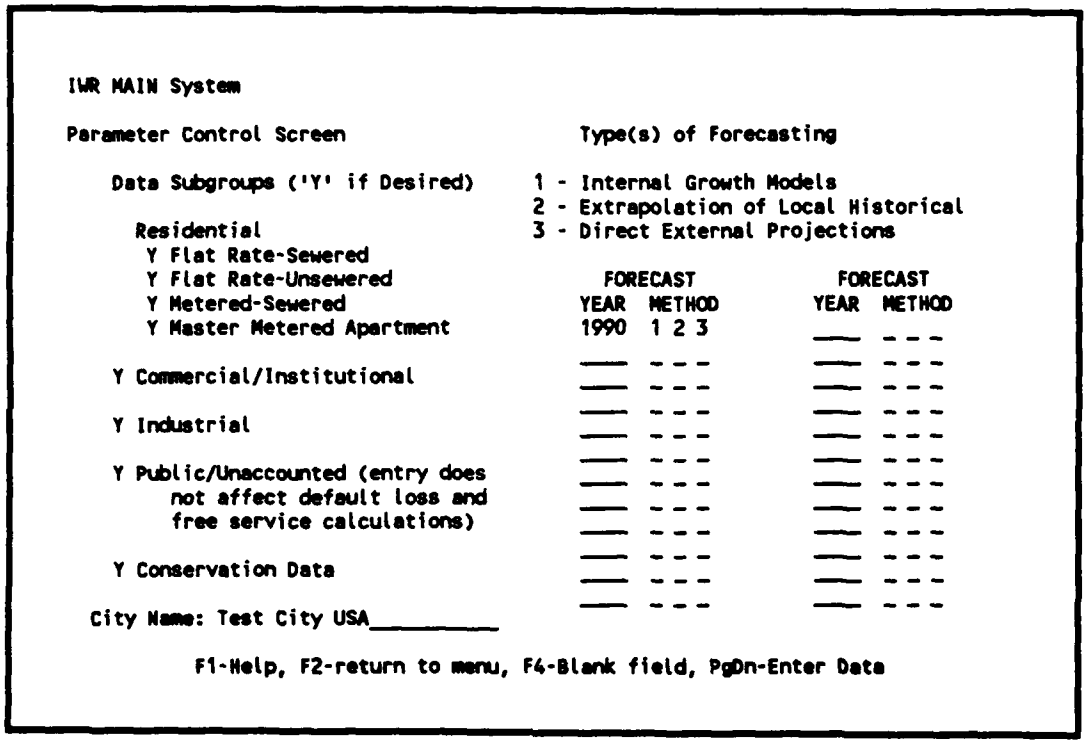
For illustrative purposes, an example file called TESTCITY is displayed on the screens throughout this chapter. This example file is not a complete file; rather, it is used to illustrate the entry procedure using the IWR-MAIN screens. A more comprehensive example is provided in Appendix A.

As we begin the data entry procedure, verify that TESTCITY is the current file (i.e., the word TESTCITY or B:TESTCITY should follow the message "Data File:" in the upper right portion of the Data Entry Main Screen). If TESTCITY is not the current file, return to the System Menu (option #6), change filenames, and return to the Data Entry Main Menu. Now select option #1 or #5 to access the Parameter Control Screen.

Note that in the Data Entry Main Menu screen, only the keys F1, F3, and PgDn are operable. The F3 and PgDn keys will skip over the Parameter Control Screen and will access empty data screens unless a data file has been previously loaded (option #2). Thus, in this screen these two keys operate the same as option #3.

3.2 THE PARAMETER CONTROL SCREEN

When selecting either option #1 (Create New File) or option #5 (Change Forecast Choices) of the Data Entry Main Screen, the Parameter Control Screen will appear.



Data Subgroups and Study Area Name

The first column of the Parameter Control Screen lists the types of water use categories (data subgroups) you may wish to address in the water use estimation or forecast. Entering "Y" (yes) means you desire to use these subgroups. Use the down cursor key to move down the column. If you wish to use the conservation subroutine to calculate restricted water use, enter "Y" for conservation. Leaving subgroups blank means you do not wish them to be included in a water use estimation. Based on your selections, only Data Entry screens appropriate to each selected subgroup will appear throughout the Data Entry procedure.

You may then type in the study area name. This name will appear on the data files and output reports that are created during the run of IWR-MAIN. Type in any identifying name up to 24 characters including both uppercase and lowercase, punctuation and numerical values, and then press RETURN. The cursor will move back to the first character of the name in case you wish to retype the name. Use the right cursor key to move to the top of the forecast year column.

Forecast Years and Forecasting Methods

If you wish to obtain forecasts of water use for other than the base year, you must specify the forecast year (which must be greater than the base year) and the methods of forecasting you wish to use. The year value must be a four-digit numerical value. If you make a mistake, you must finish typing the entire year and then return to that cell to reenter the correct value. You may specify up to 24 forecast years. For the projection of socioeconomic data from which the water use estimates are made, IWR-MAIN allows you to select from three forecast methods. Any one method, any combination of two, or all three methods can be used. Different choices and combinations may be used for each forecast year. To select the forecasting methods, enter the numbers 1, 2, and/or 3 in the blanks next to each specified forecast year and press any cursor key (not RETURN). The following lists the three methods of forecasting socioeconomic data.

(1) Internal Growth Models

The IWR-MAIN program contains a subroutine called GROWTH which uses econometric growth models based on observed historical trends in housing and employment throughout the U.S. These models were estimated from data collected at the Standard Metropolitan Statistical Area (SMSA) level by the U.S. Bureau of the Census. Use of the internal growth model without the other two methods substantially reduces the data requirements of the System. However, the use of either or both of the other two methods in addition to the growth models allows the socioeconomic projections to better reflect local area conditions.

(2) Extrapolation of Local Historical Parameters

Parameters for housing, disaggregated employment, water distribution losses, and free service can be extrapolated from historic values of these parameters as provided by the user.

(3) Direct External Projections

The same parameters for housing, disaggregated employment, distribution losses, and free service can be provided by the user with external projections made by outside sources such as planning agencies, U.S. Bureau of Census, or the IWR-MAIN external projection utility.

The example data file TESTCITY has all the subgroups and the conservation subroutine selected. It has one forecast year with all three forecasting methods selected. When all the desired entries have been made on the Parameter Control Screen, press the PgDn key to advance to the Municipal Base Year Data Screen (1.1).

3.3 BASE YEAR SCREENS

Screens 1.1 through 8.2 allow you to input data which describe the study area in the base year. Highlighted lines or columns in screens 1.1 through 5.1 indicate required data. Furthermore, base year data must be entered for all data subgroups selected in the Parameter Control Screen. Optional data may be added whenever available. Much of the optional data is utilized by the internal growth models, thus any additional information provided may enhance the parameter projections.

Note that all price and income must be in constant 1980 dollars. Also, when entering input data on the screens, do not use commas.

Screen 1.1 - Municipal Base Year Data

Screen 1.1 is the first screen which appears after the Parameter Control Screen.

```
IWR MAIN System                                              Screen No. 1.1

         Municipal Data - Base Year Data

Required data --                                      Test City USA
    Data include central city? (Y=1)  1          .PRN file requested? (Y=1) 1
    Calendar year of base year data 1980          Latitude (degrees)     35
    Resident population     479899                Longitude (degrees)    110
    Median household income (1980$)      22024
    Total base year employment     197438  5 yrs before base year     168486

Choose one --
  1.  Dept. Commerce Composite Const. Cost Index for base year (U.S.)  143.3
  2.  Alternate const. cost index for 1980 (CCAL) .....  for base year .....

Optional climatic data (in inches) --
             Enter actual values for calibration purposes only.
    Summer season --    normal  actual    Maximum-day --
      Evapotranspiration .....  .....       Evapotranspiration .....
      Precipitation      .....  .....
      Moisture deficit   .....  .....


F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

The required data (minimum data which must be entered for a successful run of the IWR-MAIN program) are highlighted.

(1) Data to include central city? -- the study area includes the central business district of the metropolitan area. This information is used by the internal growth models. Press the "1" key for yes or leave it blank for no.

(2) Calendar year -- the base year of the study (e.g., 1980).

(3) Resident population -- study area resident population for the base year.

(4) Median household income -- the median of the distribution of household income for the base year. It must be expressed in 1980 dollars.

(5) Total area employment -- the total employment for the area including manufacturing, commercial, and government for the base year (excluding agriculture, agricultural services, and mining).

(6) Total employment 5 years prior -- the total employment five years before the base year.

(7) .PRN file requested? -- selection of this entry causes IWR-MAIN to create a file with the extension (.PRN) during the Run Model procedure. This file, which includes the results of the forecast run, is designed to facilitate data analysis with a spreadsheet program. Press the "1" key for yes or leave it blank for no.

(8) Latitude (degrees) -- the latitude of the study area in rounded degrees. This will be used together with longitude to select the rain and evapotranspiration measurements for the study area from a library of long-term average weather coefficients contained in IWR-MAIN.

(9) Longitude (degrees) -- the longitude of the study area in rounded degrees. This, like latitude, will determine long-term average weather for the study area.

(10) Department of Commerce Composite Construction Cost Index for base year (U.S.) -- 143.3 for 1980. If the base year is other than 1980, any suitable construction cost index can be used as long as both the 1980 value (CCAL) and the base year value are provided.

Optional climatic data (in inches) refers to the summer season (typically June, July, and August) evapotranspiration, precipitation, and moisture deficit. Note that all references to evapotranspiration in this

manual are for potential evapotranspiration. When the "normal" evapotranspiration and precipitation measurements are provided, IWR-MAIN will not use the long-term averages based on latitude and longitude. This will speed up the processing, as the program will not have to read an additional library. IWR-MAIN uses evapotranspiration and precipitation to calculate "normal" moisture deficit; therefore, the provision of moisture deficit causes the values for evapotranspiration and precipitation to be ignored.

The long-term average summer season rainfall and evapotranspiration for combinations of latitude and longitude are stored in the library of climatic variables (FLONLAT). If one or both of these two "normal" variables is missing from the data input, and if no value is provided for "normal" moisture deficit, then the rainfall and/or evapotranspiration are read from the library file. See Part II, section 4.4, for a description of the library file.

If you wish to adjust the residential metered and sewered summer water use for actual weather conditions in a specific year to calibrate the forecast model, enter the actual weather values for the calibration year in the column marked "actual." As with the "normal" weather data, provision of the "actual" moisture deficit value will cause the values for "actual" evapotranspiration and precipitation to be ignored. If the "actual" moisture deficit value is not provided, both the "actual" evapotranspiration and precipitation values must be entered for the weather adjustment factor to be calculated and used. See Part II, section 5.3, for a detailed description of the use of the "actual" weather data in the calibration process. So that the forecasts of water use are reflective of normal weather conditions, the "actual" weather data should be deleted prior to making any final forecast runs.

The maximum-day evapotranspiration measurement is the only additional climatic parameter required for the calculation of maximum-day water use. If this value is not provided, IWR-MAIN will use one of two default values based on the longitude of the study area. If the longitude is less than 115, the default value is 0.29 inches; otherwise, the default is 0.25 inches.

For a reference of possible data sources where municipal data may be obtained, see Part II, section 3.4.

Screen 1.2 - Municipal Base Year Screen (Optional Data)

Screen 1.2 contains optional entries which, when provided, will improve the forecasting abilities of the internal growth models. However, if optional projection data for household income (screen 9.1) and/or employment data by industry group (screen 9.3) are to be used, then the corresponding data must be provided in this screen.

```
IWR MAIN System                                          Screen No. 1.2    -


Optional base year income data (supply all three) --
   Percent households with income less than $10,000 (1980$) .....
            at least $10,000 but less than $20,000 (1980$) .....
            at least $20,000 but less than $30,000 (1980$) .....


Optional employment data (supply any pair) --
   SIC 1500-1799 employment - base year       8370  5 yrs prior       7661
   SIC 2000-3999 employment - base year .....   5 yrs prior .....
   SIC 4000-4999 employment - base year .....   5 yrs prior .....
   SIC 5000-5199 employment - base year .....   5 yrs prior .....
   SIC 5200-5999 employment - base year .....   5 yrs prior .....
   SIC 6000-6799 employment - base year .....   5 yrs prior .....
   SIC 7000-8999 employment - base year .....   5 yrs prior .....
   SIC 9100-9799 employment - base year .....   5 yrs prior .....



F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

The optional base year income data are the fraction of households with annual median household incomes of less than $10,000 (1980$); at least $10,000 but less than $20,000 (1980$); and at least $20,000 but less than $30,000 (1980$). These values must be entered as fractions (i.e., 10 percent should be entered as .10). They cause alternative models to be used for some housing value projections. All three values must be provided if this option is used.

The optional employment data refer to the sector employment in the base year and five years prior to the base year, and include the following:

(1) SIC 1500-1799 -- Construction Employment
(2) SIC 2000-3999 -- Manufacturing Employment
(3) SIC 4000-4999 -- Transportation and Public Utilities Employment
(4) SIC 5000-5199 -- Wholesale Trade Employment
(5) SIC 5200-5999 -- Retail Trade Employment
(6) SIC 6000-6799 -- Finance, Insurance, and Real Estate Employment
(7) SIC 7000-8999 -- Services Employment
(8) SIC 9100-9799 -- Government Employment

(See Part II, section 3.4, for possible data sources.)

If this option is used, the data are not required for all sectors; however, you must supply the sectoral data in pairs (base year and five years prior). For example: the 1980 TESTCITY has a construction employment of 8,370; in 1975, employment for that same sector was 7,661. After screen 1.2, the following screens can be accessed corresponding with the subgroups and forecast methods selected in the Parameter Control Screen.

Screens 2.1 and 2.2 - Residential Subgroups: Flat Rate and Sewered

This subgroup includes occupied housing units that do not face a charge that varies with the quantity of water used. These customers pay a flat rate for water/wastewater services or are renter-occupied where the owner pays the water/wastewater bill. Such customers, therefore, face a zero marginal price and are not expected to react to changes in price. This category may include housing units contained in buildings with two or three units per structure and mobile home parks where a single meter serves all units. All units in this category are served by a public sewer system.

Screens 2.1 and 2.2 (not shown) allocate space for 25 sets of flat rate and sewered data, where each set represents a specified property value range.

```
IWR MAIN System                                              Screen No. 2.1

        Municipal Data - Residential Subgroups - Flat Rate Sewered
   Base Year Property
     Value   Ranges          Persons     Assessment     Density   No of Units
  Low  ($100s)  High         No/Unit      Factor       Units/Acre  In Range

        0         99.99        2.23          ...          4.00        1243
  .......     .......      ....          ...          ....      .........
  .......     .......      ....          ...          ....      .........
  .......     .......      ....          ...          ....      .........
  .......     .......      ....          ...          ....      .........
  .......     .......      ....          ...          ....      .........
  .......     .......      ....          ...          ....      .........
  .......     .......      ....          ...          ....      .........
  .......     .......      ....          ...          ....      .........
  .......     .......      ....          ...          ....      .........
  .......     .......      ....          ...          ....      .........
  .......     .......      ....          ...          ....      .........
  .......     .......      ....          ...          ....      .........


F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

The input data for each flat rate and sewered value range may include:

(1) Low -- lower limit of the property value range in $100s at base year price levels
(2) High -- upper limit of the property value range in $100s at base year price levels
(3) Persons (No./Unit) -- persons per housing unit for the value range
(4) Assessment Factor -- optional housing assessment factor for value ranges, if using assessed valuation rather than market value (equals the ratio of assessed value to market value)
(5) Density (Units/Acre) -- average density of housing units per acre for the value range
(6) No. of Units -- number of housing units within the value range

(See Part II, section 3.4, for possible data sources.)

For example: the first value range ($0 to $9,999) has 2.23 persons per housing unit, a density of four units per acre, and 1,243 housing units within that value range.

Note that water use calculations for each range are based on the midrange value. Due to the sensitivity of residential water requirements to home value, it is recommended that no individual value range be larger than necessary, preferably less than $10,000 from the lower to upper value range. Value ranges should be entered in order of increasing midrange value. This is true for all residential subgroups.

Screens 3.1 and 3.2 - Residential Subgroups: Flat Rate and Unsewered

This subgroup includes occupied housing units similar to the above category except that customers are not served by a public sewer system. Wastewater disposal is by means of a private septic tank, cesspool, or other method.

Screens 3.1 and 3.2 (not shown) allocate space for 25 sets of flat rate and unsewered data.

```
IWR MAIN System                                              Screen No. 3.1

        Municipal Data - Residential Subgroups - Flat Rate Septic
  Base Year Property
    Value    Ranges          Persons     Assessment      Density   No of Units
  Low   ($100s)  High         No/Unit      Factor       Units/Acre  In Range

        0          99.99        2.23          ...          4.00         450
  .......    .......    ....    ...    ....    .........
  .......    .......    ....    ...    ....    .........
  .......    .......    ....    ...    ....    .........
  .......    .......    ....    ...    ....    .........
  .......    .......    ....    ...    ....    .........
  .......    .......    ....    ...    ....    .........
  .......    .......    ....    ...    ....    .........
  .......    .......    ....    ...    ....    .........
  .......    .......    ....    ...    ....    .........
  .......    .......    ....    ...    ....    .........
  .......    .......    ....    ...    ....    .........
  .......    .......    ....    ...    ....    .........


F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

The input data for each flat rate and unsewered value range may include:

(1) Low -- lower limit of the property value range in $100s at base year price levels
(2) High -- upper limit of the property value range in $100s at base year price levels
(3) Persons (No./Unit) -- persons per housing unit for the specified value range
(4) Assessment Factor -- optional housing assessment factor for value ranges, if using assessed valuations rather than market value
(5) Density (Units/Acre) -- density of housing units per acre for the specified value range
(6) No. of Units -- number of housing units within the specified value range

(See Part II, section 3.4, for possible data sources.)

For example: the first value range ($0 to $9,999) has 2.23 persons per housing unit, a density of four units per acre, and 450 housing units within that value range.

Screens 4.1 and 4.2 - Residential Subgroups: Metered and Sewered

This subgroup includes single-family occupied housing units that are individually metered and are served by a public sewer system. These housing units are considered owner-occupied or occupied by renters who are responsible for paying the water and wastewater bill.

Screens 4.1 and 4.2 (not shown) allocate space for 25 sets of metered and sewered data.

```
IWR MAIN System                                              Screen No. 4.1

          Municipal Data - Residential - Metered Sewered

Base Year Property  Price of Water          Density                  Bill Difference
  Value   Ranges     Annual  Summer  Assess  Units  No of Units  $/Bill  Period
Low ($100s) High    $/K-Gal $/K-Gal Factor  /Acre    in Range   Annual  Summer

      0    99.99      0.75    0.49    ....    4.00        4496     2.53    1.65
.......  .......    .....   .....    ....  ......    ........  ......  ......
.......  .......    .....   .....    ....  ......    ........  ......  ......
.......  .......    .....   .....    ....  ......    ........  ......  ......
.......  .......    .....   .....    ....  ......    ........  ......  ......
.......  .......    .....   .....    ....  ......    ........  ......  ......
.......  .......    .....   .....    ....  ......    ........  ......  ......
.......  .......    .....   .....    ....  ......    ........  ......  ......
.......  .......    .....   .....    ....  ......    ........  ......  ......
.......  .......    .....   .....    ....  ......    ........  ......  ......
.......  .......    .....   .....    ....  ......    ........  ......  ......
.......  .......    .....   .....    ....  ......    ........  ......  ......
.......  .......    .....   .....    ....  ......    ........  ......  ......

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

The input data for each metered and sewered data value range may include:

(1) Low -- lower limit of the property value range in $100s at base year price levels
(2) High -- upper limit of the property value range in $100s at base year price levels
(3) Price of Water --
Annual - annual marginal price of water for the specified value range (dollars per 1,000 gallons) in 1980$
Summer - summer marginal price of water for the specified value range (dollars per 1,000 gallons) in 1980$
(See Part II, section 3.1, for a detailed explanation of the price variables.)
(4) Assessment Factor -- optional assessment factor for value ranges if assessed valuation is used rather than market value (default value is one (1.0))
(5) Density (Unit/Acre) -- density of housing units per acre for the specified value range
(6) No. of Units -- number of housing units within the specified value range
(7) Bill Difference --
Annual - annual bill difference for a specified value range (dollars per billing period) in 1980$
Summer - summer bill difference for a specified value range (dollars per billing period) in 1980$

(See Part II, section 3.4, for possible data sources.)

Note that bill difference variable describes the difference in the consumer's actual total bill and what would be charged if all units of water were sold at the marginal price.

The following is one example of how to calculate the bill difference:

EXAMPLE OF BILL DIFFERENCE CALCULATION

Rate Structure		Water Service
Service Charge		1.03 Dollars/Month
Up to 5,000 Gal./Mo.		0.60 Dollars/1,000 Gal.
5,001-10,000 Gal./Mo.		0.50 Dollars/1,000 Gal.
All over 10,000 Gal./Mo.		0.40 Dollars/1,000 Gal.
		Wastewater Service
All Water Use		0.35 Dollars/1,000 Gal.
Billing Period Is		One Month
Average Annual Water Use in Value Range		
350 Gal./Day		350 x 31 = 10,850 Gal.Mo.
Marginal Price		0.40 + 0.35 = 0.75 Dollars/1,000 Gal.
Bill Difference		
Total Bill:	Service Charge	1.03 Dollars
	Up to 5,000 Gal.	4.75 Dollars
	5,001-10,000 Gal.	4.25 Dollars
	Over 10,000 Gal.	0.64 Dollars
		10.67 Dollars
Less 0.75 x 10,850/1,000		8.14 Dollars
Equals Annual Bill Difference		2.53 Dollars

The example of metered and sewered data in the screen shows that in the first value range ($0 to $9,999) a customer pays an annual marginal price of $0.75 per 1,000 gallons and a summer marginal price of $0.49 per 1,000 gallons; the annual bill difference is $2.53 per billing period and the summer bill difference is $1.65 per billing period. There are 4,496 housing units in this value range with a density of four units per acre.

Screens 5.1 and 5.2 - Residential Subgroups: Master-Metered Apartments

This subgroup includes occupied housing units in structures with four or more units. The structure may be unmetered or provided with a single (master) meter. These customers face a zero marginal price of water and have limited opportunity to engage in outdoor (seasonal) water use.

Screens 5.1 and 5.2 (not shown) contain 25 sets of master-metered apartment data.

```
IWR MAIN System                                          Screen No. 5.1

        Municipal Data - Residential - Master Metered Apartments
  Base Year Property
    Value    Ranges        Persons    Assessment     No of Units
 Low ($100s)  High         No/Unit      Factor        in Range

       0       149.99        2.92         ....           5954
 .......     .......       .....        ....         .........
 .......     .......       .....        ....         .........
 .......     .......       .....        ....         .........
 .......     .......       .....        ....         .........
 .......     .......       .....        ....         .........
 .......     .......       .....        ....         .........
 .......     .......       .....        ....         .........
 .......     .......       .....        ....         .........
 .......     .......       .....        ....         .........
 .......     .......       .....        ....         .........
 .......     .......       .....        ....         .........
 .......     .......       .....        ....         .........


F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

The input data for each master-metered apartment value range may include:

(1) Low -- lower limit of the property value range in $100s at base year price levels
(2) High -- upper limit of the property value range in $100s at base year price levels
(3) Persons (No./Unit) -- persons per housing unit for the specified value range
(4) Assessment Factor -- optional household assessment factor for value ranges if using assessed valuation rather than market value
(5) No. of Units -- number of housing units within the specified value range

(See Part II, section 3.4, for possible data sources.)

For example: the first value range ($0 to $14,999) has 2.92 persons per housing unit and 5,954 housing units within that value range.

Note that through the use of the alternate construction cost indexes, property values entered in screens 2.1 through 3.2 in base year dollars are converted internally to 1980 dollars.

Screen 6.1 - Commercial Employment

Screen 6.1 contains 23 specified commercial employment categories.

```
IWR MAIN System                                          Screen No. 6.1

        Municipal Data - Commercial Employment

            Total Employment

         Description                              Description

 C001 Miscellaneous Commercial    30301  C013 Hotels, Restaurants       .......
 C002 Vocational School           .......  C014 Electric, Gas Utilities  .......
 C003 Miscellaneous Retail        .......  C015 Public Administration      56319
 C004 Boarding Houses             .......  C016 Schools, Universities    .......
 C005 Transportation Terminal     .......  C017 Race Tracks              .......
 C006 Barbers, Cleaning           .......  C018 Labs, Water Utilities    .......
 C007 Power Laundries             .......  C019 Health Services          .......
 C008 Landscaping                 .......  C020 Medical Offices, Bakeries .......
 C009 Miscellaneous Wholesale     .......  C021 Nursing Facilities       .......
 C010 Recreational Facilities     .......  C022 Hospitals                .......
 C011 Food and Auto Retail        .......  C023 Zoological, etc. Gardens .......
 C012 Dance Studios               .......

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

These categories represent combinations of Standard Industrial Classification (SIC) categories (see Part II, section 3.1). Enter the total employment for those categories which are represented in the study area. Leave blank those categories which do not apply.

For example: Miscellaneous Commercial (C001) has 30,301 employees, whereas Public Administration (C015) has 56,319 employees.

Note that none of the commercial categories are highlighted; however, if the commercial/institutional subgroup was selected in the Parameter Control Screen, then employment data must be entered for at least one category on screen 6.1 or 6.2. (See Part II, section 3.4, for possible data sources.) See the description of screen 7.7 for an adjustment of commercial water use for average commercial water prices.

Screen 6.2 - User-Added Commercial Parameters

Screens 6.2 and 6.3 (not shown) contain space for 27 additional user-specified commercial categories.

```
IWR MAIN System                                          Screen No. 6.2

          Municipal Data - User Added Commercial Parameters

                                                          Coefficients
                                      No of             Ann Avg    Max Day
Label   Description    Employment    Units   Unit Parameter  (Gallons/Day/Unit)

C024 Car Washes         .......        70   Buildings          10000     15500
C025 ................ ....... .........  ................. ......... .........
C026 ................ ....... .........  ................. ......... .........
C027 ................ ....... .........  ................. ......... .........
C028 ................ ....... .........  ................. ......... .........
C029 ................ ....... .........  ................. ......... .........
C030 ................ ....... .........  ................. ......... .........
C031 ................ ....... .........  ................. ......... .........
C032 ................ ....... .........  ................. ......... .........
C033 ................ ....... .........  ................. ......... .........
C034 ................ ....... .........  ................. ......... .........
C035 ................ ....... .........  ................. ......... .........
C036 ................ ....... .........  ................. ......... .........
C037 ................ ....... .........  ................. ......... .........

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

Enter in a brief description (such as car washes), either employment (if known) or the number of units, and the unit parameter (such as buildings or employees). Then the average annual and maximum-day water use coefficients (gallons per day per unit or per employee) must both be entered. For example: there are 70 car washes in the study area, and they use approximately 10,000 gallons per day per unit (average annual use).

Note that a specific water use type should not be addressed in both screens 6.1 and 6.2 (i.e., do not include car wash employment in screen 6.1 and then include car wash buildings in screen 6.2). Where it is not feasible to provide employment data for any of the categories on screen 6.1, it is possible to include all commercial/institutional use in one or more categories on screen 6.2 (e.g., total commercial use), provided that suitable water use data are available to calculate water use coefficients in gallons per day per unit. Therefore, total commercial water use in the base year is addressed in one of three ways: (1) by providing total commercial employment disaggregated into up to the 23 categories in screen 6.1, (2) by developing one or more user-added categories in screen 6.2, or (3) by using a combination of the two previous approaches.

Screens 7.1 through 7.6 - Industrial Employment

Screens 7.1 through 7.6 (7.2 through 7.6 not shown) contain 198 categories of manufacturing employment which are organized by Standard Industrial Classification (SIC) codes.

```
IWR MAIN System                                          Screen No. 7.1
        Municipal Data - Industrial Employment

            Total Employment
SIC      Description                    SIC     Description
201  Meat Products              282     209  Misc Foods & Kindred prod .....
2011  Meat Packing Plants       .....   211  Cigarettes                .....
2013  Sausages &Prepared Meats  .....   212  Cigars                    .....
2016  Poultry Dressing Plants   .....   213  Chewing & Smoking Tobacco .....
2017  Poultry & Egg Processing  .....   214  Tobacco Stemming&Redrying .....
202  Dairy Products             .....   221  Weaving Mills, Cotton     .....
203  Preserved Fruits & Veggys  .....   222  Weaving Mills, Synthetics .....
204  Grain Mill Products        .....   223  Weaving&Finish Mills,Wool .....
205  Bakery products            .....   224  Narrow Fabric Mills       .....
2051  Bread, Cake & Rel. Prods  120     225  Knitting Mills            .....
2052  Cookies & Crackers         29     226  Textile Finishng,exc.Wool .....
206  Sugar & Confectionery prd  .....   227  Floor Covering Mills      .....
207  Fats & Oils                .....   228  Yarn & Thread Mills       .....
208  Beverages                  .....   229  Misc. Textile Goods       .....
2082  Malt Beverages            .....   230  Apparel&Other Textile Prd .....
2086  Bottled& Canned Soft Dks  .....   241  Logging Camps&Lg Contrctr .....
2087  Flavoring Extracts&Syrup  .....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

If a three-digit SIC category is disaggregated into four-digit subcategories, you may specify employment data at either the three-digit level or the four-digit level. However, if you specify employment at the three-digit level you cannot specify it at the four-digit level as well. Furthermore, if you specify employment at the four-digit level, all four-digit categories within the given three-digit category must contain a value of zero or greater.

For example: Meat Products (SIC 201) has an employment of 282. Employment for the four-digit SIC subcategories within Bakery Products (SIC 205) is 120 for SIC 2051 and 29 for SIC 2052.

Note that none of the categories are highlighted; however, if the industrial subgroup was selected in the Parameter Control Screen, then employment data must be entered for at least one category on screens 7.1 through 7.7. (See Part II, section 3.4, for possible data sources.)

Screen 7.7 - User-Added Industrial Parameters and Nonresidential Prices

Screen 7.7 provides two additional industrial categories that may be user-specified.

```
IWR MAIN System                                          Screen No. 7.7

        Municipal Data - User Added Industrial Parameters

                                                    Coefficients
                                                  Ann Avg      Max Day
   Label      Description              Employment  Gals/Day     Gals/Day

   I199     High Tech Gadgets             1345       178.9        198.9

   I200     ........................     .......    .........    .........


        Municipal Data - Commercial and Industrial Water Prices

        Marginal Price in Base Year      Marginal Price Concurrent with
                                             Water Use Coefficients
              $/1000 gallons                    $/1000 gallons

   Commercial          .88                            .95

   Industrial        ......                         ......

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

Since the specified water use parameter is employment, the corresponding water use coefficient must be entered as gallons per employee per day. Note that the water-using activities should not appear more than once (i.e., employment counted in one or more categories on screens 7.1 through 7.6 should not be addressed again on screen 7.7). Where it is not feasible to provide employment data for any of the industrial categories on screens 7.1 through 7.6, it is possible to include all manufacturing use as one or two categories on screen 7.7 (e.g., total manufacturing), provided suitable water use and employment data are available to calculate water use per employee coefficients.

Nonresidential water use is calculated by multiplying the category parameter (e.g., employment) by the category's water use coefficient. The coefficients for the 23 commercial and 198 industrial specified categories were developed from survey data as explained in Part II, section 4.1. The commercial coefficients are from 1984 data while the industrial coefficients are from 1982 data. Given that nonresidential water users respond to increases in water and wastewater prices as indicated by a price elasticity for the commercial or industrial sector, the estimated water use can be adjusted for any price difference between the base year and the year in which the water use coefficients were estimated. If you wish to make this adjustment for price differences for either sector (or both), enter the marginal price in dollars per thousand gallons for the sector in both the base year and the year of the coefficients (1984 for commercial coefficients and 1982 for industrial coefficients). Note that the year of the coefficients may change if you revise the coefficients in the library. (See Part II, section 5.3, for a discussion of adjusting nonresidential water use rates.) Both prices must be entered for a sector in order to compute the price adjustment, and both prices must be entered in 1980$. See Part II, section 4.1, for details of the nonresidential price adjustment computation.

For example: user-added industrial category I199, High Tech Gadgets, has an employment of 1,345 and an annual average and maximum-day coefficient of 178.9 gallons per employee per day and 198.9 gallons per employee per day, respectively, Also, marginal commercial price in the base year is $0.88 per 1,000 gallons and the marginal price concurrent with water use coefficients (1984) is $0.95 per 1,000 gallons in 1980 dollars.

Screen 8.1 - Public/Unaccounted

Screen 8.1 allows data to be entered for public/unaccounted subgroups.

```
IWR MAIN System                                          Screen No. 8.1


                Municipal Data - Public/Unaccounted


                                 Resident     Annual Average  Max Daily
          Category               Population      Gallons/Day  Gals/Day

      Distribution Losses        .........       ..........   ..........

      Free Service                               ..........   ..........




If water use is given, Average and Max-Day must both be entered.

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

When no parameters on this screen are provided, distribution loss is calculated as a percentage (as provided in the Library of Water Use Coefficients-FLSS) of the total municipal water use (or production). However, if you enter a nonzero value for population, the model will calculate distribution losses on a per capita basis (using the library coefficient-LOSS). Free service is always calculated on a per capita basis using resident population from screen 1.1 and can only be suppressed by setting the library coefficient (FSER) to zero. Note that the population entered on screen 8.1 is the population served by the distribution system and, therefore, may not be the same as the population provided on screen 1.1.

Alternatively, direct estimates of public/unaccounted use (distribution losses and free service) in gallons per day can be supplied for both average annual and maximum-day water use and will override the calculations described above.

Screens 8.2 and 8.3 - User-Added Public/Unaccounted Parameters

Screen 8.2 contains 27 additional user-specified public/unaccounted water use parameters.

```
IWR MAIN System                                          Screen No. 8.2

      Municipal Data - User Added Public/Unaccounted Parameters

                                                    Coefficients
                                 No of                Ann Avg    Max Day
Label   Description              Units   Unit Parameter (Gallons/Day/Unit)

 P001 State Parks                  125  Restrooms          1000       2000
 P002 .................    .........  ..............  .........  .........
 P003 .................    .........  ..............  .........  .........
 P004 .................    .........  ..............  .........  .........
 P005 .................    .........  ..............  .........  .........
 P006 .................    .........  ..............  .........  .........
 P007 .................    .........  ..............  .........  .........
 P008 .................    .........  ..............  .........  .........
 P009 .................    .........  ..............  .........  .........
 P010 .................    .........  ..............  .........  .........
 P011 .................    .........  ..............  .........  .........
 P012 .................    .........  ..............  .........  .........
 P013 .................    .........  ..............  .........  .........
 P014 .................    .........  ..............  .........  .........

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

If you have information on a specific public water use category (that is not accounted for elsewhere), you may provide a description of the category, number of units, unit parameter, and water use coefficients in gallons per day per unit.

For example: state parks in the study area are known to have 125 restrooms (units) which consume 1,000 gallons per day per unit annually and 2,000 gallons per day per unit on a maximum-use day. Before defining a user-added category, it should be determined that the water-using activity is not included in some other category (e.g., commercial or industrial).

3.4 PROJECTION SCREENS USED BY INTERNAL GROWTH MODELS

Projection screens contain parameters which are used by the internal growth models to project disaggregated parameter data for the forecast years selected. Regardless of the forecast method selected, certain parameters (population, median household income, and total employment) must be provided for each forecast year. These required data are highlighted on each screen. When used, the optional data (total number of households and households by income range) improve the performance of the internal growth models.

Screens 9.1 and 9.2 - Projection Data for Internal Growth Models

Screens 9.1 and 9.2 (not shown) allow projection data to be provided for the forecast years specified in the Parameter Control Screen.

```
IWR MAIN System                                              Screen No. 9.1

        Projection Data for Internal Growth Models

Year    Populatn   Medn HH    Total      Total No.   % Households w/Income (1980$)
>Base              Income     Employmnt  Households  <10,000   10,000--   20,000--
                   (1980$)                                     <20,000    <30,000

1990      532761     24472      208722      153259   ........  ........   ........
....      ........   .......    ........    ........ ........  ........   ........
....      ........   .......    ........    ........ ........  ........   ........
....      ........   .......    ........    ........ ........  ........   ........
....      ........   .......    ........    ........ ........  ........   ........
....      ........   .......    ........    ........ ........  ........   ........
....      ........   .......    ........    ........ ........  ........   ........
....      ........   .......    ........    ........ ........  ........   ........
....      ........   .......    ........    ........ ........  ........   ........
....      ........   .......    ........    ........ ........  ........   ........
....      ........   .......    ........    ........ ........  ........   ........
....      ........   .......    ........    ........ ........  ........   ........


F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

Screens 9.1 and 9.2 contain the following parameters for which data may be provided:

Required:

(1) Population -- total resident population for study area

(2) Median Household Income (1980$) -- annual median household income expressed in 1980 dollars

(3) Total Employment -- total employment for study area

Optional:

(4) Total No. Households -- total number of occupied housing units in the study area

(5) Percent Households with Income (1980$) --

< 10,000 - fraction of households in the study area with an annual median household income of less than $10,000 (in 1980 dollars)

10,000 - < 20,000 - fraction of households with an annual median household income of at least $10,000 but less than $20,000 (in 1980 dollars)

20,000 - < 30,000 - fraction of household with an annual median household income of at least $20,000 but less than $30,000 (in 1980 dollars)

Note that if these optional parameters for household income are used, all three fractions must be provided, and corresponding data must be entered in screen 1.2. (See Part II, section 3.4, for possible data sources.)

For example: in the forecast year 1990, projected population is estimated to be 532,761 and the household income to be $24,472. Projected employment is estimated to be 208,722, and the total number of housing units is projected to be 153,259. [Screen 9.2 is a continuation of screen 9.1.]

Screens 9.3 and 9.4 - Projection Data for Internal Growth Models: Employment by Industry Group

Screens 9.3 and 9.4 (not shown) allow employment projection data to be provided for 24 forecast years.

```
IWR MAIN System                                          Screen No. 9.3

      Projection Data for Internal Growth Models

                  Employment by Industry Group (SIC Codes)

Year    1500--   2000--   4000--   5000--   5200--   6000--   7000--   9100--
>Base     1799     3999     4999     5199     5999     6799     8999     9799

1990      9191  .......  .......  .......  .......  .......  .......  .......
....   .......  .......  .......  .......  .......  .......  .......  .......
....   .......  .......  .......  .......  .......  .......  .......  .......
....   .......  .......  .......  .......  .......  .......  .......  .......
....   .......  .......  .......  .......  .......  .......  .......  .......
....   .......  .......  .......  .......  .......  .......  .......  .......
....   .......  .......  .......  .......  .......  .......  .......  .......
....   .......  .......  .......  .......  .......  .......  .......  .......
....   .......  .......  .......  .......  .......  .......  .......  .......
....   .......  .......  .......  .......  .......  .......  .......  .......
....   .......  .......  .......  .......  .......  .......  .......  .......
....   .......  .......  .......  .......  .......  .......  .......  .......

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

Employment is entered by major industry groups (e.g., construction, manufacturing, retail). See the description of screen 1.2 on page I-15 for the list of the major industrial groups. Note that if these optional parameters are provided, corresponding data must be entered in screen 1.2. It is desirable, but not necessary, to supply data for all groups for a specified forecast year.

For example: in the year 1990, projected employment for SIC categories 1500-1799 (construction) is 9,191.

3.5 HISTORICAL PARAMETER SCREENS

When extrapolation of local historical data is selected as a forecast method on the Parameter Control Screen, you will be prompted to provide historical data for the water use parameters. For any of the Historical Parameter screens used, you must provide actual data for at least two past years which may include the base year but not more than seven years. The IWR-MAIN System will use this information to perform a straight-line extrapolation of parameter data to the forecast years. You may be selective in that you do not have to provide historical data for all screens or all categories.

Screens 10.1 and 10.2 - Residential Subgroups

Screens 10.1 and 10.2 (not shown) contain historical data parameters for each of the residential subgroups. The flat rate and sewered and the flat rate and unsewered data are entered in screen 10.1, while the metered and sewered and the master-metered apartment data are entered in screen 10.2.

```
IWR MAIN System                                              Screen No. 10.1

        Projection by Extrapolation of Local Historical Trends

        Residential -- Flat Rate-Sewered -- No. Housing Units
Year    Low Grp.      Grp. 2      Grp. 3      High Grp.      Total
....    ........    ........    ........    ........    ........
....    ........    ........    ........    ........    ........
....    ........    ........    ........    ........    ........
....    ........    ........    ........    ........    ........
....    ........    ........    ........    ........    ........
....    ........    ........    ........    ........    ........
....    ........    ........    ........    ........    ........

        Residential -- Flat Rate-Unsewered -- No. Housing Units
Year    Low Grp.      Grp. 2      Grp. 3      High Grp.      Total
....    ........    ........    ........    ........    ........
....    ........    ........    ........    ........    ........
....    ........    ........    ........    ........    ........
....    ........    ........    ........    ........    ........
....    ........    ........    ........    ........    ........
....    ........    ........    ........    ........    ........
....    ........    ........    ........    ........    ........
F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

Specify the years for which the historical parameter data are to be entered for a given residential subgroup (e.g., flat rate and sewered), and enter the number of occupied units in each of the following value range groups.

(1) Low Group (Group 1) -- total housing units in all value ranges having midrange values less than $25,000 when expressed in 1980 dollars

(2) Group 2 -- total housing units in all value ranges having midrange values greater than $25,000 but less than $50,000 when expressed in 1980 dollars

(3) Group 3 -- total housing units in all value ranges having midrange values greater than $50,000 but less than $100,000 when expressed in 1980 dollars

(4) High Group (Group 4) -- total housing units in all value ranges having midrange values greater than $100,000 when expressed in 1980 dollars

(5) Total -- total number of housing units in the specified year

Screens 11.1 through 11.4 - Commercial Subgroups

Screens 11.1 through 11.4 (11.2 through 11.4 not shown) contain the 50 commercial water use categories.

```
IWR MAIN System                                              Screen No. 11.1
    Projection Data by Extrapolation of Historical Commercial Parameters
Year   1960       1965       1970       1975        ....       ....       ....
C001     28000      29000      29580      30000  .........  .........  .........
C002 .........  .........  .........  .........  .........  .........  .........
C003 .........  .........  .........  .........  .........  .........  .........
C004 .........  .........  .........  .........  .........  .........  .........
C005 .........  .........  .........  .........  .........  .........  .........
C006 .........  .........  .........  .........  .........  .........  .........
C007 .........  .........  .........  .........  .........  .........  .........
C008 .........  .........  .........  .........  .........  .........  .........
C009 .........  .........  .........  .........  .........  .........  .........
C010 .........  .........  .........  .........  .........  .........  .........
C011 .........  .........  .........  .........  .........  .........  .........
C012 .........  .........  .........  .........  .........  .........  .........



         Bold fields indicate those used in base year.



F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

The line labeled YEAR is highlighted and at least two years must be entered. The year values must be four-digit numerical values and may include the base year. The year entered above each column in screen 11.1 will automatically appear above the corresponding column in the remaining screens (11.2 through 11.4).

All commercial categories used in the base year input screens will be highlighted to facilitate data entry. Enter the historical years and the number of employees (or other parameter if user-specified) in each category for which you desire a historical extrapolation. Not all categories used in the base year need to be addressed.

For example: since C001 was used in the base year (screen 6.1), it is highlighted. Actual data values are provided for the years 1960, 1965, 1970, and 1975.

Screens 12.1 through 12.a - Industrial Subgroups

Screens 12.1 through 12.a contain the 200 industrial water use categories.

```
IWR MAIN System    See Help (F1 key) for explanation       Screen No. 12.1
    Projection Data by Extrapolation of Historical Industrial Parameters
Year   1950       1960       1970       ....       ....       ....       ....
201  .........  .........  .........  .........  .........  .........  .........
2011 .........  .........  .........  .........  .........  .........  .........
2013 .........  .........  .........  .........  .........  .........  .........
2016 .........  .........  .........  .........  .........  .........  .........
2017 .........  .........  .........  .........  .........  .........  .........
202  .........  .........  .........  .........  .........  .........  .........
203  .........  .........  .........  .........  .........  .........  .........
204  .........  .........  .........  .........  .........  .........  .........
205  .........  .........  .........  .........  .........  .........  .........
2051       300        296        278  .........  .........  .........  .........
2052 .........  .........  .........  .........  .........  .........  .........
206  .........  .........  .........  .........  .........  .........  .........
207  .........  .........  .........  .........  .........  .........  .........
208  .........  .........  .........  .........  .........  .........  .........
2082 .........  .........  .........  .........  .........  .........  .........
2086 .........  .........  .........  .........  .........  .........  .........
2087 .........  .........  .........  .........  .........  .........  .........
209  .........  .........  .........  .........  .........  .........  .........
211  .........  .........  .........  .........  .........  .........  .........
212  .........  .........  .........  .........  .........  .........  .........
F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

As with the commercial sector, at least two years are required. The years and all those categories used in the base year will be highlighted. Supply the years and employment for the categories for which you desire historical extrapolation. Again, not all highlighted categories need to be addressed.

For example: category 2051 was used in the base year (screen 7.1) and, therefore, it is highlighted. Actual data values are provided for the years 1950, 1960, and 1970.

Screens 13.1 and 13.2 - Public/Unaccounted Subgroups

Screens 13.1 and 13.2 (not shown) provide space for historical parameters for the public/unaccounted sectors. The categories correspond with those provided in screens 8.1 and 8.2.

```
IWR MAIN System                                              Screen No. 13.1
    Projection Data by Extrapolation of Historical Public/Unaccounted
Year   ....       ....       ....       ....       ....       ....       ....
LOSS ..........  ..........  ..........  ..........  ..........  ..........  ..........
FSER ..........  ..........  ..........  ..........  ..........  ..........  ..........
P001 ..........  ..........  ..........  ..........  ..........  ..........  ..........
P002 ..........  ..........  ..........  ..........  ..........  ..........  ..........
P003 ..........  ..........  ..........  ..........  ..........  ..........  ..........
P004 ..........  ..........  ..........  ..........  ..........  ..........  ..........
P005 ..........  ..........  ..........  ..........  ..........  ..........  ..........
P006 ..........  ..........  ..........  ..........  ..........  ..........  ..........
P007 ..........  ..........  ..........  ..........  ..........  ..........  ..........
P008 ..........  ..........  ..........  ..........  ..........  ..........  ..........
P009 ..........  ..........  ..........  ..........  ..........  ..........  ..........
P010 ..........  ..........  ..........  ..........  ..........  ..........  ..........
P011 ..........  ..........  ..........  ..........  ..........  ..........  ..........
P012 ..........  ..........  ..........  ..........  ..........  ..........  ..........

          Bold fields indicate those used in base year.
F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

As with the commercial and industrial Historical Parameter screens, the line YEAR is highlighted and entry of at least two years are required. Year values must be four-digit numerical values. The lines LOSS (distribution losses) and FSER (free service) are highlighted, as well as any user-specified categories that were selected in the base year. Enter historical population for LOSS and FSER for the respective per capita calculations. Enter the parameter data for whichever user-added category historical information is known. LOSS and FSER are highlighted even though data may not have been entered in screen 8.1 because default values are assumed for these parameters from the population data in screen 9.1. Parameters projected from historical data will take precedence over growth model projections.

3.6 EXTERNAL PROJECTION SCREENS

These screens allow direct external projections of parameters used in the four major subgroups: residential, commercial, industrial, and public/unaccounted for each of the first ten specified forecast years. It is not necessary that data be entered for all of the forecast years or all water use subgroups. Enter data in those years and those categories for which you have specific information.

For each of the forecast years a series of nine screens are available (one residential, two commercial, four industrial, and two public/unaccounted). The residential screen for the second forecast year follows the public/unaccounted screen(s) for the first forecast year. Thus, you will have access to all the external projection screens of one year before proceeding to the next forecast year. The screen numbers reflect the sequence of both years and sectors. For example, the screens for the first forecast year are screens 14.1.1 through 14.1.9 while the screens for the second forecast year are numbered 14.2.1 through 14.2.9. In the following screen descriptions, the letter x within the screen number represents the forecast year corresponding to a given screen.

Screen 14.x.1 - Residential - Direct External Projections

```
IWR MAIN System                                          Screen No. 14.1.1
        Direct External Projections: 1990 - Residential

      Category &     No. Units        Category &     No. Units
      Value Range       in            Value Range       in
        Group          Group            Group          Group

         FWG1        ........           FPG1        ........
         FWG2        ........           FPG2        ........
         FWG3        ........           FPG3        ........
         FWG4        ........           FPG4        ........
         FWTL        ........           FPTL        ........

         MWG1          37338            APG1        ........
         MWG2        ........           APG2        ........
         MWG3        ........           APG3        ........
         MWG4        ........           APG4        ........
         MWTL          110015           APTL        ........


F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

If you wish to supply external projections for the residential sector, enter the number of occupied housing units for any of the specified category and value range groups. The first two characters of the group label indicate the residential subgroup. The last two characters are either the price range of corresponding subgroups or a total count. All price ranges should be expressed in 1980 dollars. The allowed combinations include:

Residential Subgroups

(1) FP - flat rate and unsewered
(2) FW - flat rate and sewered
(3) AP - master-metered apartment
(4) MW - metered and sewered

Value Range Group

(1) G1 - midrange market value less than $25,000 (1980$)
(2) G2 - midrange market value of at least $25,000 but not more than $50,000 (1980$)
(3) G3 - midrange market value of at least $50,000 but not more than $100,000 (1980$)
(4) G4 - midrange market value of at least $100,000 (1980$)
(5) TL - total occupied housing units

For example: for 1990, it is estimated that 37,338 metered and sewered housing units will be in value ranges having midrange values in the low value group ($0 - $25,000 expressed in 1980 dollars). The total number of housing units in the metered and sewered housing subgroup is estimated to be 110,015. These two residential categories are labeled MWG1 and MWTL, respectively.

Screens 14.x.2 and 14.x.3 - Commercial - Direct External Projections

```
IWR MAIN System                                          Screen No. 14.1.2
        Direct External Projections: 1990 - Commercial

Category   Parameter   Employment        Category   Parameter   Employment

    C001   ..........  ..........            C018   ..........  ..........
    C002   ..........  ..........            C019   ..........  ..........
    C003   ..........  ..........            C020   ..........  ..........
    C004   ..........  ..........            C021   ..........  ..........
    C005   ..........  ..........            C022   ..........  ..........
    C006   ..........  ..........            C023   ..........  ..........
    C007   ..........  ..........            C024   ..........  ..........
    C008   ..........  ..........            C025   ..........  ..........
    C009   ..........  ..........            C026   ..........  ..........
    C010   ..........  ..........            C027   ..........  ..........
    C011   ..........  ..........            C028   ..........  ..........
    C012   ..........  ..........            C029   ..........  ..........
    C013   ..........  ..........            C030   ..........  ..........
    C014   ..........  ..........            C031   ..........  ..........
    C015   ..........       62000            C032   ..........  ..........
    C016   ..........  ..........            C033   ..........  ..........
    C017   ..........  ..........            C034   ..........  ..........

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

The categories for the commercial sector correspond to the C001-C050 groupings observed in screens 6.1 and 6.2. The SIC categories contained in each C0xx grouping are specified in Tables 3-2 and 3-3 of Part II, section 3.1. Note that the categories for which data were entered in screens 6.1 and 6.2 are highlighted. However, data entry is neither limited to nor required for these categories. Enter the number of employees for any of categories C001-C023, and use whatever user-specified parameter you indicated for categories C024-C050. Press the page down (PgDn) key to access additional screens for categories C035-C050.

Screens 14.x.4 through 14.x.7 - Industrial - Direct External Projections

```
IWR MAIN System                                          Screen No. 14.1.4
        Direct External Projections: 1990 - Industrial

Category   Employment        Category   Employment        Category   Employment

    I001   ..........            I018   ..........            I035   ..........
    I002   ..........            I019   ..........            I036   ..........
    I003   ..........            I020   ..........            I037   ..........
    I004   ..........            I021   ..........            I038   ..........
    I005   ..........            I022   ..........            I039   ..........
    I006   ..........            I023   ..........            I040   ..........
    I007          860            I024   ..........            I041   ..........
    I008   ..........            I025   ..........            I042   ..........
    I009   ..........            I026   ..........            I043   ..........
    I010   ..........            I027   ..........            I044   ..........
    I011   ..........            I028   ..........            I045   ..........
    I012   ..........            I029   ..........            I046   ..........
    I013   ..........            I030   ..........            I047   ..........
    I014   ..........            I031   ..........            I048   ..........
    I015   ..........            I032   ..........            I049   ..........
    I016   ..........            I033   ..........            I050   ..........
    I017   ..........            I034   ..........            I051   ..........

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

The I001-I200 categories for the industrial sector correspond to the groupings used in screens 7.1 to 7.7 For a crossreference between SIC codes used in screens 7.1 to 7.6 and the corresponding (Ixxx) categories, see Part II, Table 3-4. Note that the categories for which data were entered in screens 7.1 to 7.6 are highlighted. Data entry is neither limited to nor required for these categories. The parameter requested is employment for the corresponding category. As with the data entry for screens 7.1 to 7.6, do not enter parameter values which are for both the three-digit and four-digit SIC level of the same category. Use the page down (PgDn) key to access the additional screens.

Screens 14.x.8 and 14.x.9 - Public/Unaccounted - Direct External Projections

```
IWR MAIN System                                              Screen No. 14.1.8
          Direct External Projections: 1990 - Public/Unaccounted
                          Water Use (gallons per day)   Fractional
Label       Parameter      Annual ave.  Max. Daily       Percent

FLSS                                                      .....
LOSS        ..........     ..........   ..........
FSER        ..........     ..........   ..........
P001        ..........     ..........   ..........
P002        ..........     ..........   ..........
P003        ..........     ..........   ..........
P004        ..........     ..........   ..........
P005        ..........     ..........   ..........
P006        ..........     ..........   ..........
P007        ..........     ..........   ..........
P008        ..........     ..........   ..........
P009        ..........     ..........   ..........
P010        ..........     ..........   ..........
P011        ..........     ..........   ..........
P012        ..........     ..........   ..........
P013        ..........     ..........   ..........
P014        ..........     ..........   ..........

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

Direct external projections for the public and unaccounted-for categories may be entered in a number of ways. Projections for distribution losses may be entered as (1) a fractional percent (FLSS) of total municipal water use, (2) the population served (parameter for LOSS) for a per capita computation, or (3) the estimated average annual and maximum-day water use in gallons per day. See Part II, section 4.1, for a discussion of the alternative calculations of distribution losses. If the percent of total municipal water use is entered, the value must be entered as a decimal (e.g., 20 percent unaccounted would be entered as 0.20).

External projections for free service (FSER) may be entered as either the population served for a per capita computation or as direct estimates of the average annual and maximum-day water use in gallons per day. Similarly, projections for any user-added public category P001-P027 may be entered as a parameter or as estimates of average annual and maximum-day water use. The parameter value, if used, must correspond with the parameter unit for a given category as specified on screen 8.2 or 8.3. Water use estimates, if used, are in gallons per day.

Note that the three labels FLSS, LOSS, and FSER are all highlighted. If no data are provided for either FLSS or LOSS, distribution losses will be calculated using the default percentage loss from the library. Likewise, if no data are provided for FSER, the free service will be calculated using the population for the forecast year in screen 9.1 and the default per capita water use. Public user-added categories specified in screen 8.2 will also be highlighted.

3.7 CONSERVATION SCREENS

When the Conservation Data option is selected on the Parameter Control Screen, IWR-MAIN will generate estimates of water use which are restricted by conservation measures defined in the following screens.

Restricted water use reflects the effectiveness of the conservation measures during the base year and each forecast year. By definition, effectiveness is calculated as the product of three quantities: unrestricted water use, the reduction factor, and the coverage factor (Baumann et al., 1980).

$$E_{msdt} = R_{msd} * C_{mst} * Q_{std}$$

where

E_{msdt} is the effectiveness of measure m in sector s for dimension d in year t measured in gallons per day.

R_{msd} is the fraction reduction in the use of water for the dimension of water use d (e.g., indoor use) for sector s (e.g., metered and sewered) expected as a result of implementing measure m (e.g., a conservation-oriented plumbing code).

C_{mst} is the coverage of measure m in sector s at time t expressed as a fraction of sectoral water use; e.g., if a plumbing code is implemented in the community on January 1, 1987, then the coverage value for the metered and sewered sector s in the future year t is defined as the proportion of the metered and sewered use affected by the plumbing code. This can be approximated by the ratio of new housing units to the total projected number of units for that year.

Q_{std} is the projected unrestricted water use for the dimension of water use d in sector s at time t in quantity per unit time (gallons per day). The water use dimensions are indoor, outdoor, and maximum-day use. See Part II, section 4.3, for details.

The IWR-MAIN Library of Conservation Coefficients (LCC) contains default values for reduction factors and selected parameters for the internal calculation of coverage factors. If you select conservation measures without specifying the reduction or coverage factors, the LCC will provide these factors for you. Alternately, you may decide to provide some or all of the reduction and coverage factors for the selected conservation measures. If only some values are provided, the LCC will provide the others. See Part II, section 4.3, for an explanation and a listing of the conservation parameters in the library.

Screen 15.1 - Selection of Measures

Screen 15.1 enables you to select up to 18 conservation measures by specifying the year of initiation for the desired measures. Fourteen measures are specified and will have reduction and coverage factors available in the library. Four additional measures can be user-specified; if used, the reduction and coverage factors must be provided by the user.

```
IWR MAIN System    Selection of Measures and Year of Initiation  Screen 15.1
              Enter year for those measures desired
Number Measure Description                                      Year
-------------------------------------------------------------------
   1      Public Education Program                               1975
   2      Metering                                               ....
   3      Pressure Reduction                                     ....
   4      Pricing Policy (Rate Reform)                           ....
   5      Rationing (Per Capita)                                 ....
   6      Sprinkling Restrictions                                ....
   7      Industrial Reuse/Recycle                               ....
   8      Commercial Reuse/Recycle                               ....
   9      Leak Detection and Repair                              ....
  10      Retrofit of Showerheads and Toilets                    ....
  11      Moderate Plumbing Code                                 1980
  12      Advanced Plumbing Code                                 ....
  13      Low-Water Use Landscaping (New)                        ....
  14      Low-Water Use Landscaping (Retrofit)                   ....
  15      User-Specified Measure Number 1                        ....
  16      User-Specified Measure Number 2                        ....
  17      User-Specified Measure Number 3                        ....
  18      User-Specified Measure Number 4                        ....

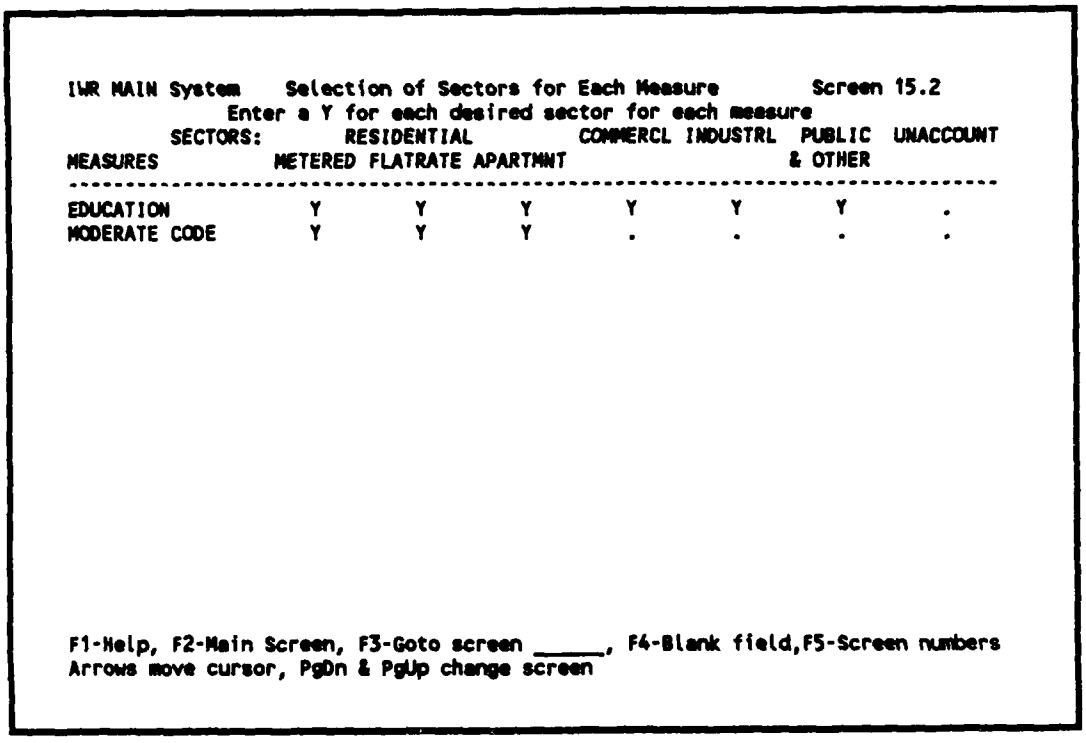
F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen numbers
Up and down arrows move cursor, PgDn & PgUp change screen
```

For example: measure 1, Public Education Program, started in 1975. This measure consists of direct mail campaigns, news media campaigns, and/or special events. Measure 11, Moderate Plumbing Code, started in 1980. This measure requires water-saving devices for all new construction. See Part II, section 4.3, for a full description of all the model-specified conservation measures.

All four digits designating a given calendar year must be specified. Any mistakes must be corrected after typing the complete four-digit year. If you specify an initiation year greater than the base year, the measure will not have an impact on unrestricted water use until some future date (after its implementation date). An initiation year less than or equal to the base year indicates that the conservation measure is already in effect.

Screen 15.2 - Selection of Sectors

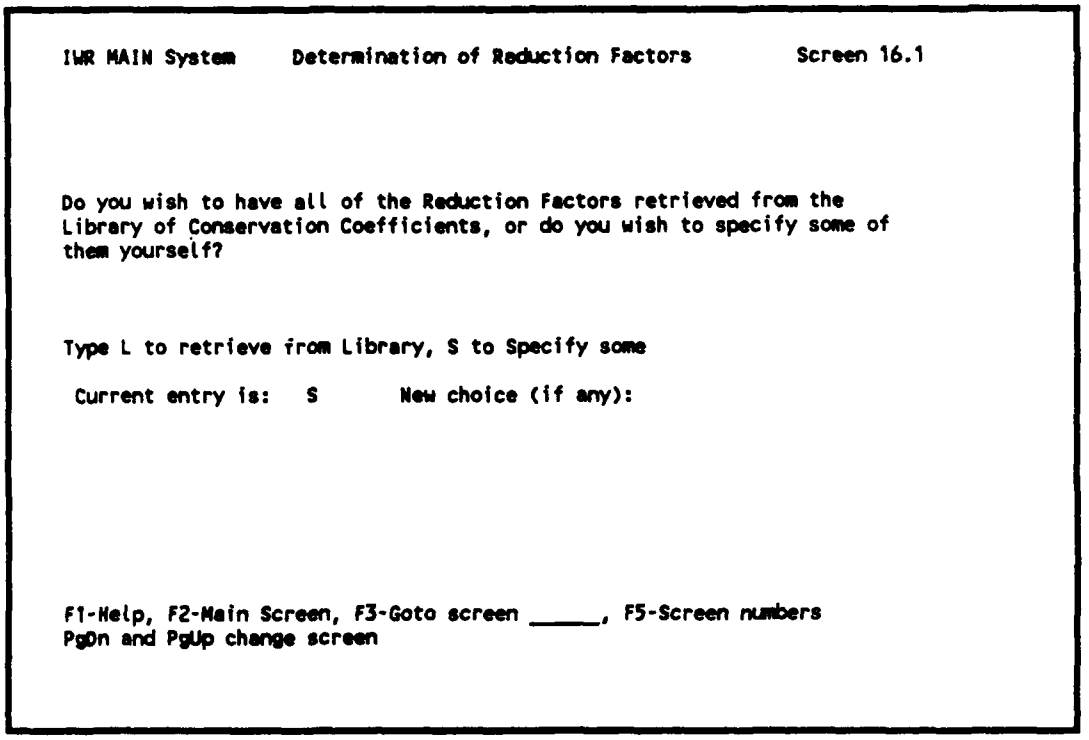
Screen 15.2 enables you to specify the sectors that will be affected by the implementation of a given conservation measure. Only those measures selected in screen 15.1 will appear in screen 15.2. Entering "Y" means the specified sector will be affected by the conservation measure, while a blank indicates that the sector is not affected by the measure.



For example: measure 1, Public Education Program identified on screen 15.2 as Education, will affect all the residential sectors, the commercial, the industrial, and the public and other sectors. Alternately, the Moderate Plumbing Code is designed to affect only the residential sectors.

Screen 16.1 - Determination of Reduction Factors

Screen 16.1 prompts you as to whether all the reduction factors should be obtained from the Library of Conservation Coefficients or whether you want to specify some or all of the values.



The Current Entry will show "L" if you are creating a new file or if "L" was previously specified. "S" will show as the current entry if you are viewing the Data Entry screens of a data file in which reduction factors were specified. Enter "S" if you want to specify some (or all) of the values, or enter "L" to obtain all the values from the library. The Current Entry will automatically switch to indicate your most recent entry. When "S" is entered, screen 16.1 will be followed by screens 16.2 through 16.4. There is one screen for each dimension: indoor, outdoor, and maximum-day use. When "L" is entered, screen 16.1 will be followed by screen 17.1.

Note that if using user-specified conservation measures, you must specify all applicable values. No default library values are available for these measures. Omission of the reduction factor for a user-specified measure will result in zero effectiveness for the affected measure and dimension.

Screen 16.2 - Reduction Factors (Indoor Use)

Screen 16.2 allows for the input of the expected indoor water use reduction resulting from the implementation of a selected conservation measure.

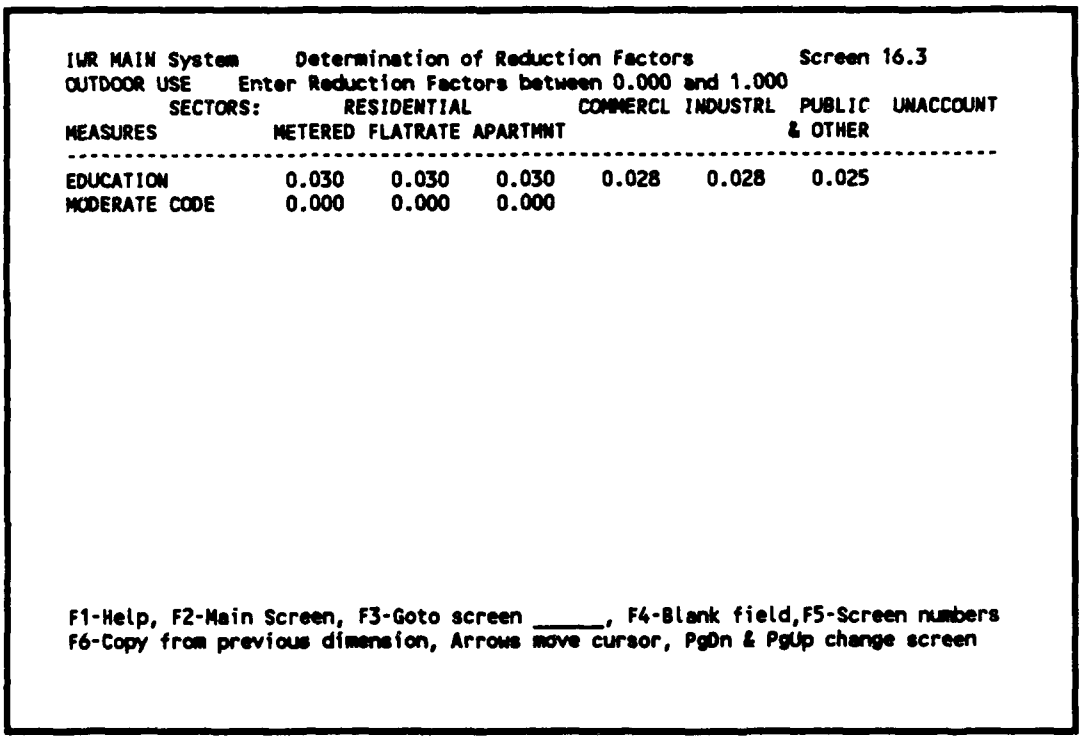
```
IWR MAIN System     Determination of Reduction Factors          Screen 16.2
INDOOR USE     Enter Reduction Factors between 0.000 and 1.000
         SECTORS:       RESIDENTIAL          COMMERCL INDUSTRL  PUBLIC  UNACCOUNT
MEASURES           METERED FLATRATE APARTMNT                    & OTHER
-------------------------------------------------------------------------------
EDUCATION           0.030    0.030    0.030    0.028    0.028    0.025
MODERATE CODE       0.250    0.180    0.180
F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen numbers
F6-Copy from previous dimension, Arrows move cursor, PgDn & PgUp change screen
```

The reduction factors are entered as a fraction of reduction in water use for each measure and applicable sector. Spaces are made available for the measures and sectors specified in the preceding screens. However, you must decide if a selected measure is applicable to indoor use, outdoor use, or both. Enter a value between 0.000 and 1.000 (it must begin with a decimal (.), a zero, or a 1). Pressing the right cursor key adds the remaining zeros after the number. Leaving sectors blank will force the library to provide the default values.

For example: measure 1, Education, has a value of 0.030 for metered and sewered housing; this implies that for this sector, the reduction of unrestricted indoor water use is expected to be 3 percent as a result of the education program.

Screen 16.3 - Reduction Factors (Outdoor Use)

Screen 16.3 has the same purpose as screen 16.2, except that it reflects reduction factors for outdoor use.



In addition to entering the desired reduction values, you have the option of copying values for that measure and that sector from the previous screen by pressing the F6 key when the cursor is at the appropriate field or leaving the field blank to use the library coefficients.

Screen 16.4 - Reduction Factors (Maximum-Day Use)

Screen 16.4 has the same purpose as screens 16.2 and 16.3, except that it reflects reduction factors for maximum-day use. Note that residential maximum-day water use is calculated as maximum-day sprinkling use plus indoor use. (See the maximum-day use equations in Tables 4-1 through 4-4.) Conservation adjustments calculated using the maximum-day reduction factors are applied to the maximum-day sprinkling use while the indoor use is adjusted for conservation using the indoor reduction factors.

```
IWR MAIN System     Determination of Reduction Factors          Screen 16.4
MAX-DAY USE    Enter Reduction Factors between 0.000 and 1.000
       SECTORS:       RESIDENTIAL          COMMERCL INDUSTRL  PUBLIC  UNACCOUNT
MEASURES          METERED FLATRATE APARTMNT                    & OTHER
-------------------------------------------------------------------------------
EDUCATION          0.030    0.030    0.030    0.028    0.028    0.025
MODERATE CODE      0.250    0.180    0.180


F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen numbers
F6-Copy from previous dimension, Arrows move cursor, PgDn & PgUp change screen
```

Again, reduction factors can be entered, the F6 key can be used to copy values from screen 16.3, or the spaces can be left blank to use the library coefficients.

Screen 17.1 - Determination of Coverage Factors

Screen 17.1 allows you to specify whether you want to use the library coefficients for the calculation of coverage factors (default) or whether you want to specify some or all of the coverage values. (See Part II, section 4.3, for a description of the default calculation of coverage factors.)

```
IWR MAIN System     Determination of Coverage Factors          Screen 17.1



Do you wish to have all of the Coverage Factors computed from the
Library of Conservation Coefficients, or do you wish to specify some of
them yourself?


Type L to compute from Library, S to Specify some

 Current entry is:   S       New choice (if any):









F1-Help, F2-Main Screen, F3-Goto screen _____, F5-Screen numbers
PgDn and PgUp change screen
```

As in screen 16.1, the Current Entry will show "L" if you are creating a new file or viewing Data Entry screens of a data file in which coverage factors were not previously specified. Type "S" to specify some (or all) values, or type "L" for the default calculation of all the values for all the years. Since the market penetration of some conservation measures may vary over time, a screen is presented for the base year and each forecast year if "S" is entered.

Note that if using user-specified conservation measures, you must specify all applicable values. Omission of the coverage factor for a user-specified measure will result in zero effectiveness for that measure and time period.

Screens 17.2 through 17.x - Determination of Coverage Factors

The first screen (17.2) is for the base year. The following screens (17.3 - 17.x) are for the specified forecast years as listed on the Parameter Control Screen.

```
IWR MAIN System     Determination of Coverage Factors          Screen 17.2
Base Year:     1980    Enter Coverage Factors between 0.000 and 1.000
        SECTORS:       RESIDENTIAL          COMMERCL INDUSTRL  PUBLIC  UNACCOUNT
MEASURES          METERED FLATRATE APARTMNT                    & OTHER
-------------------------------------------------------------------------------
EDUCATION          0.850    0.850    0.850    0.680    0.680    0.580
MODERATE CODE      0.500    0.450    0.450

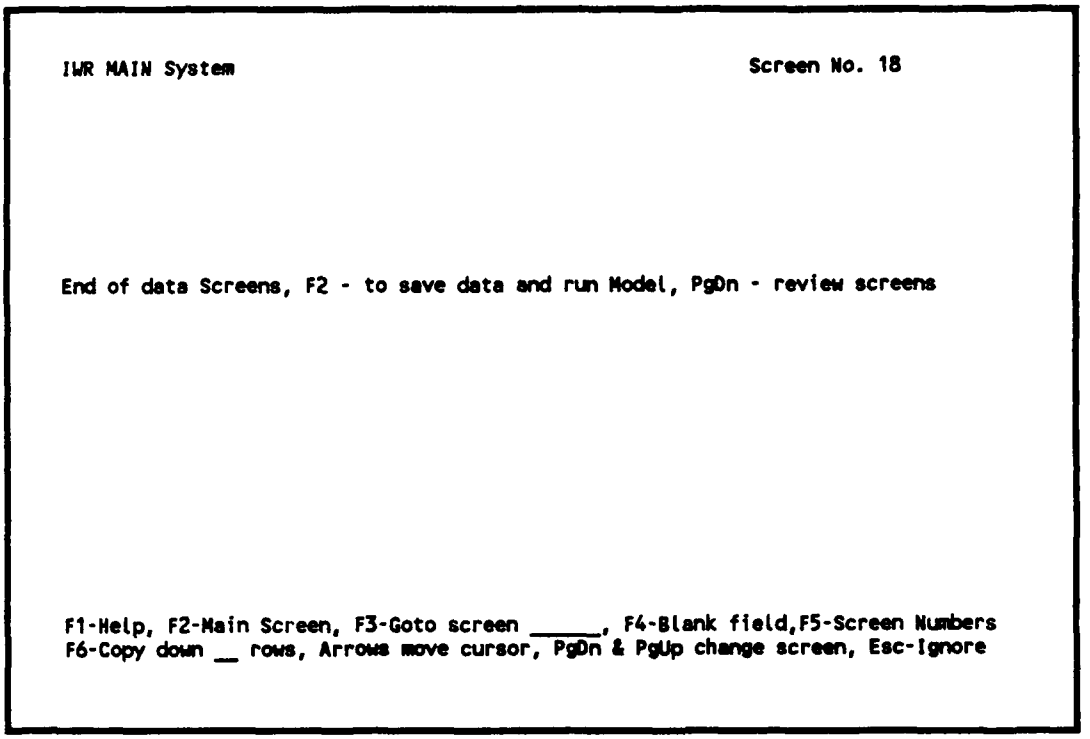

F1-Help, F2-Main Screen, F3-Goto screen _____,F4-Blank field, F5-Screen numbers
F6-Copy from previous year, Arrows move cursor, PgDn and PgUp change screen
```

Entering the coverage factors is similar to entering the reduction factors. Values must be between 0.000 and 1.000 and begin with either a decimal (.), zero, or a 1.

The right cursor key will fill in the remaining zeros after a number. The F6 key can be used to copy values from previous screens (F6 cannot be used on the first screen 17.2). Leaving values blank will cause IWR-MAIN to calculate coverage factors using coefficients provided in the library.

For example: an entry of 0.85 for metered and sewered housing implies that 85 percent of unrestricted water use in metered and sewered housing is affected by the education program.

Screen 18 appears when all data have been entered as specified by the Parameter Control Screen.



3.8 TERMINATING DATA/ENTRY

After entering the data using the IWR-MAIN screens, press the F2 key to return to the Data Entry Main Screen. Here you have the option of editing and making changes (option #3), saving the file under a new name (option #4), editing the Parameter Control Screen (option #5), or returning to the System Menu with a file save option (option #6).

It is very important that Create New File (option #1) or Load Existing File (option #2) are not selected before saving the current file. Selecting either option will cause the current file to be destroyed.

To end a data entry or editing session, press F2. Then select option #6. Save the data file you have just left by responding "Y" (yes) to both the save file and overwrite file prompts and confirm return (Y) to the IWR-MAIN System Menu.

```
IWR MAIN System                                          Screen No. 0

    Data Entry Main Screen

  1) Create New File                  Data File:  b:testcity

  2) Load Existing File

  3) Add More Data/Revise Existing Data

  4) Save Current File With New Filename

  5) Change Subgroups/Forecast Choices

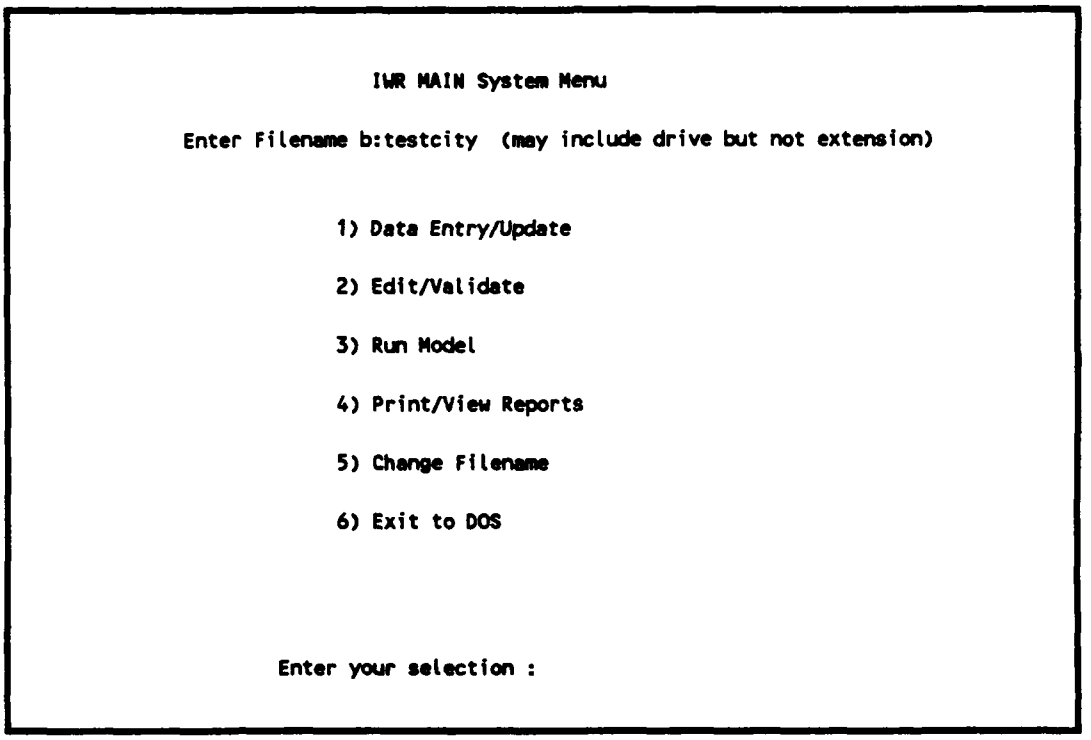
  6) Save Current File and/or Return to System Menu

        Enter Selection: _


F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
```

4. EDIT/VALIDATE PROCEDURE

4.1 INTRODUCTION TO EDIT/VALIDATE



If you are ready to run the model after the data have been entered or edited on the IWR-MAIN screens, you must then perform the Edit/Validate procedure. When IWR-MAIN saved your screen-inputted data file, the data file was saved without a filename extension. If you were to edit this file using DOS or any full-screen editor you would see a long, narrow string of numbers in a seemingly unformatted structure (actually it is formatted, but the format is only meaningful to the Data Entry procedure).

The purposes of the Edit/Validate procedure are (1) to internally check whether all required data have been entered and (2) to create and format the files needed for execution of IWR-MAIN. This procedure does not provide the user with the ability to edit the data. If errors occur during either the Edit/Validate or Run Model procedure, return to the Data Entry procedure to correct the source of the error.

After saving the file and returning to the Main System Menu from the Data Entry procedure, select Edit/Validate (procedure #2). The Edit/Validate procedure must be performed after you create or edit a file (procedure #1) and before you run the model (procedure #3). Depending on the size of your input file and the type of hardware used, this procedure may take between one and three minutes. The following sections describe the activities which occur during the Edit/Validate procedure.

During this procedure, screen messages are displayed corresponding with the various subroutines performed within the procedure. At any time you may stop the scrolling of these messages on your screen by pressing the PAUSE key on your keyboard. If your keyboard does not have a PAUSE key, consult your operating system manual for the appropriate combination of keys to pause, or temporarily interrupt, processing. Press any key to continue.

4.2 INPUT DATA VERIFICATION

The first step in the Edit/Validate procedure is to verify the input data. The procedure will not check the validity of the data; rather, it searches for the presence of required data inputs and checks category names. It also makes sure that three-digit and four-digit SIC employment data for the same manufacturing category are not used together.

If errors are found, error messages will be displayed on the screen and the program will return to the Main System Menu. Errors can be resolved by returning to the Data Entry procedure and correcting the input.

If no errors are found, the procedure lists the base and forecast years on the screen followed by the data subgroups which were selected for the water use forecast.

4.3 CREATION OF THE .DAT AND .WOR FILES

When you saved the TESTCITY file using option #4 or #6 of the Main Data Entry Menu, you created a file called TESTCITY.(no extension). During the Edit/Validate procedure, a formatted data file is created (which appears as the filename with the extension .DAT).

During Edit/Validate, the file (without extension) is loaded into memory, is reformatted into a file readable by the IWR-MAIN computation routines, and is saved with the extension .DAT. The .DAT data file is a structured ASCII file which you can edit using any text editor. However, this is not recommended since data input changes can be made using the Data Entry/Update procedure (and repeating Edit/Validate) in order to change the .DAT file. Also note that if changes are made to the .DAT file using a text editor, the source data file (file without extension) used in the Data Entry/Update procedure will no longer correspond with your .DAT file. (See Appendix C for a description of the utility which will create a data file from your .DAT file.) The .DAT file will be the data file used during the IWR-MAIN System run. At this step of the procedure, two files exist: one without an extension and one with the .DAT extension.

```
                          TESTCITY.
TESTCITY--------> TESTCITY.DAT
```

The next steps of the Edit/Validate procedure depend on the contents of the data file. If no user-added catgories were entered during the Data Entry, the procedure copies the COFLB51 file (which is the IWR-MAIN Library of Water Use Coefficients) into a file with the extension .WOR. Although the COFLB51 file contains water use coefficients needed, the IWR-MAIN program actually uses the .WOR file.

```
COFLB51----------> TESTCITY.WOR
```

The Edit/Validate procedure then terminates, and the Main System Menu returns.

4.4 CREATION OF THE .ULB AND .WOR FILES

If there are user-specified categories in the data file during the Edit/Validate procedure, IWR-MAIN would also create a file called .ULB (user library) to ensure that the COFLB51 file remains unchanged. This .ULB file is structured and labeled the same as the .WOR file (an ASCII formatted file). However, the .ULB file contains only the user-specified parameters and labels.

Since IWR-MAIN uses the .WOR file in the program run, the user- specified parameters must be merged into the .WOR file. The Edit/ Validate procedure reads the COFLB51 file and the .ULB file into memory and merges them to create the modified .WOR file. Now the .WOR file contains the user-specified values, leaving the COFLB51 library untouched.

The Edit/Validate procedure then terminates, and the Main System Menu appears.

Since user-specified values were entered in our example, there would be four working files after the completion of the Edit/Validate procedure:

TESTCITY.	unformatted source data file created during Data Entry and converted during Edit/Validate
TESTCITY.DAT	formatted data file created during Edit/Validate and used during the Run Model
TESTCITY.ULB	library containing user-added categories, merged into TESTCITY.WOR file during Edit/Validate
TESTCITY.WOR	working copy of the COFLB51 library file (also including data from the .ULB file) created during Edit/Validate and used during Run Model

4.5 AN ADDED FEATURE

Since some users may wish to calibrate the coefficients library to reflect local conditions of the study area, IWR-MAIN allows you to make changes in the library without affecting the COFLB51 file. (See Part II, section 4.4, for the format of the library and Part II, section 5, for a discussion of calibration procedures.)

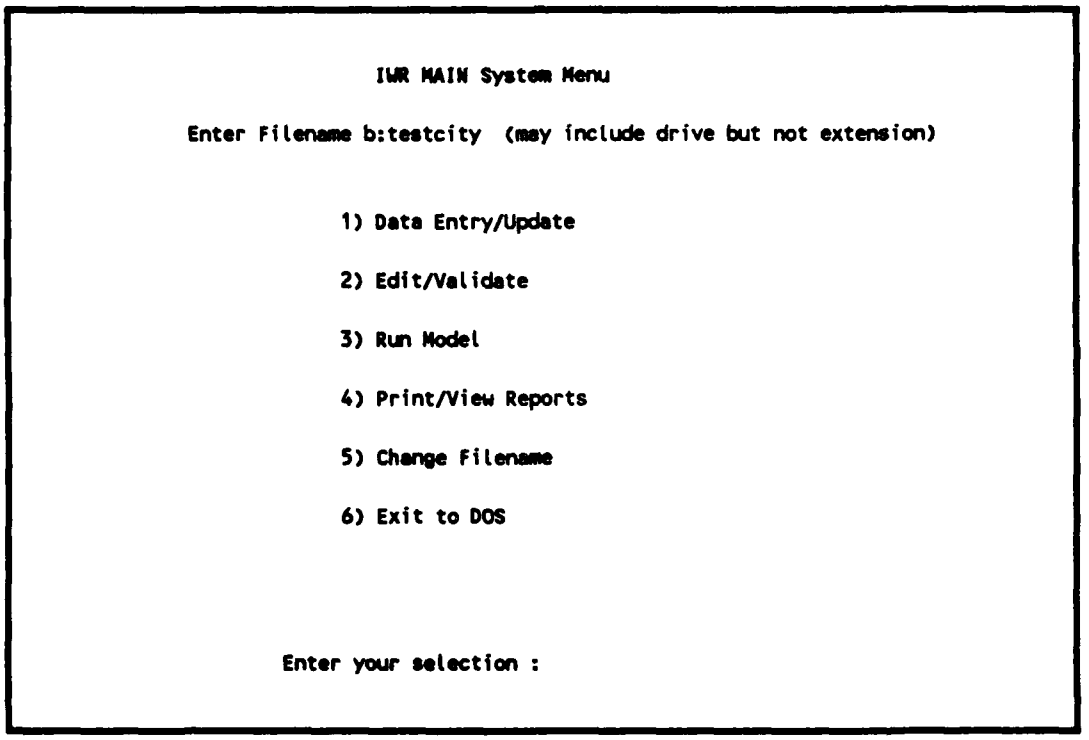
After running the model at least once to check the accuracy of the results, calibration changes can be made in the .WOR file using any text editor (see Part II, sections 4 and 5). If you then change any data using the Data/Entry screens, you must save and Edit/Validate again. Normally during the Edit/Validate procedure, the COFLB51 (untouched and uncalibrated) will be copied or merged into a new .WOR file. However, this would overwrite all calibrations made in the original .WOR file.

Therefore, during the Edit/Validate procedure, IWR-MAIN checks first to see if a .WOR file exists. If one does not exist, the program assumes that this is a first run and proceeds as normal. If a .WOR file already exists, the program will pause to allow you to choose between "normal copy" or "skip copy" in order to prevent the COFLB51 from overwriting the existing .WOR file. If calibrations to the library have not been made, you should allow the COFLB51 file to copy or merge into the .WOR file (normal copy). However, if the existing library (.WOR) contains calibrated coefficients, indicate that you do not want the COFLB51 to overwrite your .WOR file (skip copy).

For illustrative purposes, a simplified flow chart diagram of the Edit/Validate procedure is included in Appendix C.

5. RUN MODEL PROCEDURE

5.1 INTRODUCTION TO RUN MODEL



After successful completion of the Edit/Validate procedure, the next step is to perform the Run Model procedure. In order to compute the water use forecast, this Run Model procedure uses the .DAT and .WOR files created by Edit/Validate along with two IWR-MAIN libraries FLONLAT and LCC. In addition, if there are forecast years selected, a temporary scratch file PROJD will be created and used throughout the Run Model procedure. To start the Run Model procedure, select procedure #3 on the Main System Menu.

During the run of the IWR-MAIN System, the model goes through a detailed series of computational procedures. A brief description is provided below along with the screen messages which appear during the procedures.

5.2 DESCRIPTION OF THE COMPUTATIONAL SEQUENCE

The first step performed by the Run Model procedure is the assignment of filenames to all the files used or created. As in the Edit/Validate procedure, all permanent files have the same name but have different extensions. These files will be displayed on the screen after the message:

THE FOLLOWING FILE(S) ASSIGNED FOR THIS RUN OF MAINIWR:

Note that MAINIWR is a filename used within the routine and is not a reference to the entire IWR-MAIN System. The procedure then reads the data (.DAT) file. The following message appears on the screen:

READING FILE (filename).DAT

This message is followed by the word REDINP (reading input) and the contents of the .DAT file. If errors are present in subgroup names, parameter names, or the form of the Construction Cost Index, they will be identified

and the program will terminate and return to the Main System Menu. If an error occurs, the program will pause to allow you to read the error indicators. Another way to observe these error messages is to have your printer on line and to press the Ctrl and PrtSc keys before selecting procedure #3 (Run Model). Now everything displayed on the screen will be captured by the printer. When the procedure returns to the System Menu, remember to press the Ctrl and PrtSc keys again in order to end the routing of displays to the printer.

During the reading of the .DAT file, the model checks for conservation data. If these data are present, the user-specified data are displayed on the screen as they are read. The model then reads the Library of Conservation Coefficients (LCC). If conservation measures are not indicated in the .DAT file, the model bypasses the reading of the LCC and goes to the next step.

There is a pause while the procedure checks to see if forecast years are present. If no forecast years have been selected, the model proceeds to the reading of the .WOR file. If forecast years are detected, the forecast year data are displayed on the screen as they are read from the .DAT file, and the data are checked for valid projection input subgroups. There is another pause while the GROWTH subroutine projects water use parameters by using historical extrapolations and/or the internal growth models. These projections are stored into a temporary file PROJD, and the model then reads the .WOR file.

After the routine reads the ENDINPUT statement from the .DAT file, the .WOR file containing the water use coefficients is read into memory, and the message appears on the screen:

READING FILE (filename).WOR

If the climatic variables evapotranspiration (EVAP) and/or rainfall (RAIN) were not specified by you, the routine will read these variables from the Library of Climatic Variables (FLONLAT). This library contains long-term averages of rainfall and evapotranspiration based on the longitude and latitude of the study area.

IWR-MAIN is now ready to begin computing water use one year at a time beginning with the base year. Screen messages appear as the calculation of unrestricted water use for each selected sector begins:

RESIDENTIAL USAGE ROUTINE

If you have provided actual weather data for calibration purposes (see the description of screen 1.1), the calculated weather adjustment factor for residential metered summer water use will be shown on the screen.

COMMERCIAL/INSTITUTIONAL USAGE ROUTINE

INDUSTRIAL USAGE ROUTINE

PUBLIC/UNACCOUNTED USAGE ROUTINE

If conservation is specified, the message appears on the screen:

CONSERVATION ROUTINE

Conservation coverage factors that you have not provided for the given year are calculated based on the LCC coefficients and parameter units in the .DAT file. These calculated factors are written into a .COV file along with the user-specified coverage factors, if any. This .COV file contains the coverage factors for each conservation measure for each year. The file is labeled and can be viewed and/or printed by any text editor. The purpose of the file is to allow you to view all coverage factors, both user- and model-specified, for all the selected measures. Estimated water savings for each measure are calculated for each sector and dimension. These savings per measure are also written to the .COV file.

Restricted water use for the year is then calculated for each sector. Results of the computations of both unrestricted and restricted water use for each sector for the year are written to an output file. There is one output

file generated for each year. The base year output is written to the file .RP1, and the first forecast year is written to the file .RP2, etc. The message appears on the screen:

WRITING REPORTS 1 THRU 12 TO FILE (filename).RP1

If forecast years are present, the message will appear:

LOADING FORECAST YEAR DATA

The projected parameter data will be read from the temporary file PROJD. Calculation of water use for each sector will follow, and the results will be written to the output file for that year. The corresponding messages will appear on the screen, and the process will be repeated for every specified forecast year. If there is at least one specified forecast year, a summary report will be written to the last output file, and the message will appear:

WRITING SUMMARY REPORT TO FILE (filename).RPx

If you specified in screen 1.1 that the data base file .PRN be produced, the file will be created at this stage and the message will appear:

WRITING RESULTS TO DATA BASE FILE (filename).PRN

This file contains summary results of the forecast without labels and can be used with data base and spreadsheet programs for data manipulation and graphics. For more information concerning this feature, see Appendix C.

The program then checks for any additional input data, and the message appears:

CHECKING INPUT FOR ADDITIONAL DATA

If data are found, the procedure returns to the read input step, otherwise you will get the message:

NO ADDITIONAL DATA FOUND

Finally, an index (.MAT) file is created for the reports, and the temporary PROJD file is deleted. Upon completion of the Run Model procedure, the program automatically exits to the System Menu. The following message will appear before the system returns to the System Menu:

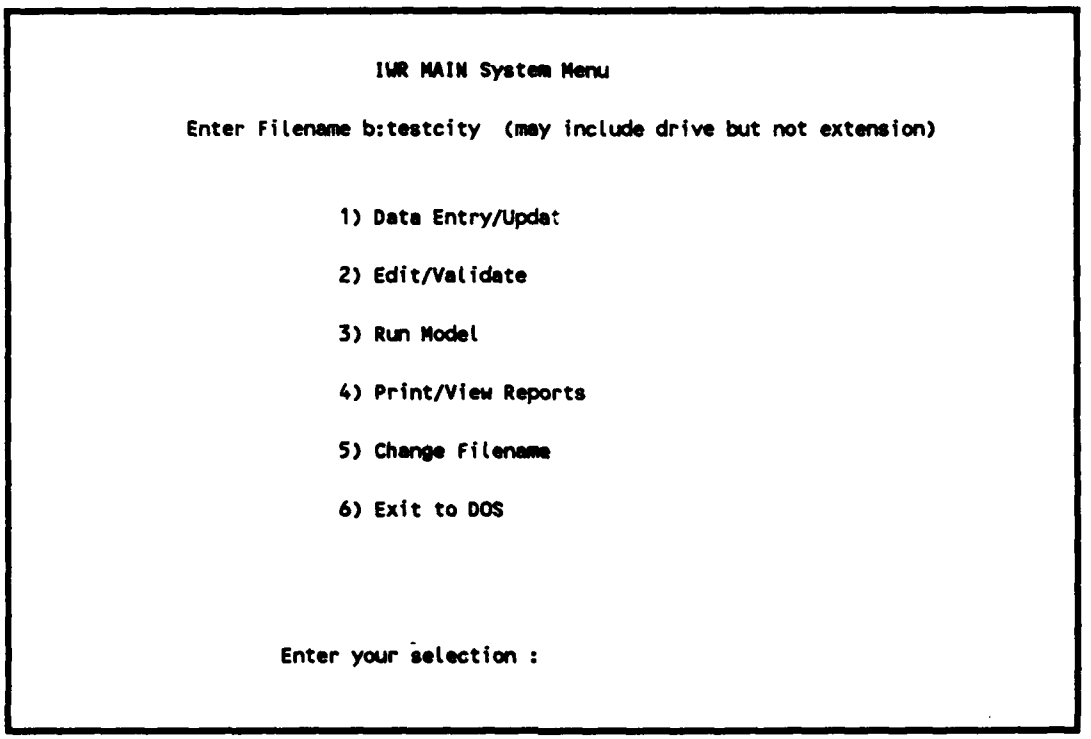
PROGRAM NORMAL EXIT

Remember to disengage the printer (Ctrl - PrtSc) if you were having the screen messages sent to your printer.

Simplified and detailed flow chart diagrams of the Run Model procedure are included in Appendix C.

6. PRINT/VIEW PROCEDURE

6.1 INTRODUCTION TO PRINT/VIEW



The Print/View procedure allows you to either print or view on screen the completed reports of the water use forecast. The Run Model procedure must have been successfully performed for the chosen filename at some time prior to the selection of this procedure. The Print/View procedure uses the .MAT and .RPx files created by the Run Model procedure to search for and display the reports for a given year(s). To activate Print/View select procedure #4 on the Main System Menu.

6.2 DESCRIPTION OF THE .RPx FILES

During the Run Model procedure, an output report file is generated for each year for which water use is computed. The base year output is written to the output .RP1 file, and the first forecast year output is written to the .RP2 file. Thus, for x number of years, report files .RP1 through .RPx will be generated. If ten reports are generated, they would be written to files .RP1 through .RPA. The summary report (report no. 13) is always written to the last year's file. The .RPx files contain the reports for each year. These reports are numbered 1-13.

Report	Water Use Title
1	Flat Rate and Unsewered
2	Flat Rate and Sewered
3	Master-Metered Apartments
4	Metered and Sewered
5	Residential Summary
6	Commercial/Institutional, Unrestricted
7	Commercial w/Conservation
8	Industrial, Unrestricted

9	Industrial w/Conservation
10	Public/Unaccounted, Unrestricted
11	Public w/Conservation
12	Municipal Summary
13	Forecast Summary

Note that the reports are in standard ASCII format and may also be viewed or printed with a text editor. Also note that reports 1-5, 12, and 13 show both unrestricted and restricted water use if conservation is indicated.

6.3 OPERATION OF PRINT/VIEW

After selecting procedure #4 on the Main System Menu, the list of reports available from your forecast run will appear:

OPENING FILES ... PLEASE WAIT
THE FOLLOWING REPORTS ARE AVAILABLE:

YEAR: 1980, REPORT(S): 1 2 3 4 5 6 7 8 9 10 11 12
YEAR: 1990, REPORT(S): 1 2 3 4 5 6 7 8 9 10 11 12
Report 13 (summary) was generated

Notice only two years, 1980 and 1990, are listed. In this example, TESTCITY has all 12 reports for both years and a summary report (#13).

After the list of available reports, press the return key and the options for selecting years and reports will be displayed.

SPECIFY THE DESIRED YEAR AND REPORT(S) IN ONE OF THE FOLLOWING FORMATS, PRESS [ENTER] AFTER EACH LINE THEN SPECIFY EITHER "P" OR "V" WHEN ALL SELECTIONS HAVE BEEN COMPLETED.
year report(s) - specify year and report(s) separated by a comma and in ascending order, e.g. "1990 5,9,12"
"*" reports(s) - selects specified report(s) for all years, e.g. "* 2,3"
year "*" - selects all reports for a specified year, e.g. "1990 *"
"*" "*" - selects all reports for all years
"S" - selects Summary report no. 13
"C" - clears all existing selections
"N"/"L" - name or list available reports
"P"/"V" - print or view all selections
"Q" - exit to main menu, quit

You may now specify the year and the reports for that year which you wish to either view or print. Enter the year and report numbers in the following format:

1990 5,10,12

Note that the year is specified as four digits followed by one space and that the report numbers are separated by commas and are in ascending order. If you wish to select the same report(s) for all years, use the format:

*** 5,10,12**

In this case, the asterisk is before the space and signifies all years. Likewise, you may select all reports for a given year using the format:

1990 *

In this format, the asterisk is after the space and signifies all reports for that year. All reports for all years may be selected using the format:

* *

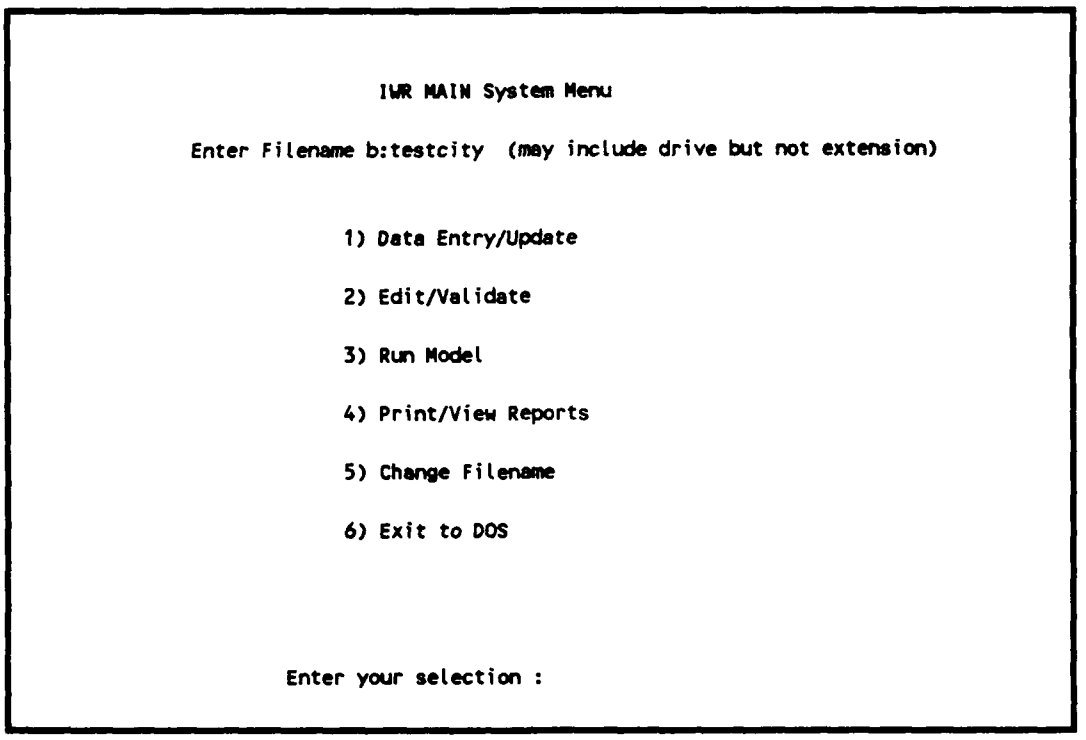
If the summary report no. 13 was generated, it may be selected by specifying summary ("S").

Once a selection has been made, press the return key. The print/view routine will search for the specified reports and send those reports to a temporary file (.WRK). When this process is complete, the routine will return to the screen and display all of your previous selections. You may enter another year/report specification, view the names or list the available reports ("N" or "L"), or clear all previous selections ("C"). When your list of specifications is complete, enter "P" or "V" and press return to send your selections to either the printer or the screen. You may also quit ("Q") the print/view routine at this time which will automatically clear all selections, delete the .WRK file, and return you to the IWR-MAIN System Menu. Additional year/report specifications add those reports to the existing .WRK file until you select either clear ("C") or quit ("Q"). Selection of print ("P") or view ("V") will send the contents of the .WRK file to the printer or screen, respectively. (Be sure your printer is connected and turned on.)

Note that the size of the .WRK file depends on how many reports are selected. When using diskettes, selecting all ("* *") will cause a large .WRK file to be created. If the space on the data diskette is exhausted, the program will terminate.

After printing or viewing the selected reports, the routine returns to the screen and displays all previous selections. Again, you have available all the specification options. You may either clear the previous selections ("C") and specify new selections or return to the IWR-MAIN System Menu ("Q").

7. EXIT TO DOS



Select option #6 (Exit to DOS) after all options have been successfully completed to return to the DOS system. You may end the session by exiting to DOS any time the System Menu screen appears. In review, you may wish to see the directory of the data files created by IWR-MAIN. To do this just type:

dir b:(filename).*

where b: indicates the drive in which the data files are located. For our example TESTCITY, eight data files have been created. These are listed and briefly described below.

TESTCITY.	unformatted source data file created during Data Entry and converted during Edit/Validate
TESTCITY.DAT	formatted data file created during Edit/Validate and used during Run Model
TESTCITY.ULB	library containing user-added categories which is merged into TESTCITY.WOR file during Edit/Validate
TESTCITY.WOR	working library created during Edit/Validate and used during Run Model
TESTCITY.COV	contains coverage factors for specified conservation measures and is created during Run Model
TESTCITY.RPx	x number of files, each containing output reports for a given year, created during Run Model
TESTCITY.PRN	a data base file containing output results created during Run Model
TESTCITY.MAT	a matrix file used by Print/View to list and locate reports
TESTCITY.WRK	a scratch file created by Print/View to search and display the reports

All of these files are in standard ASCII format and may be viewed or printed using standard DOS commands or edited through use of a line or screen editor. However, unless you are familiar with the IWR-MAIN program and the consequences of editing data files created by the program, altering these files is not recommended.

Once a complete run has been executed, you may return to the IWR-MAIN System at any time to edit or update the files, print or view the reports, or rerun the model.

A complete simplified flow chart diagram of the entire IWR-MAIN System is included in Appendix C.

8. MINIMUM DATA REQUIREMENTS--A GUIDE FOR FIRST-TIME USERS

For first-time users of IWR-MAIN, Table I-1 provides a guide to inputting data for generating successful runs of the program. The forecasts generated by following Table 1 are for the base year only without conservation and without forecast years. See the description of the corresponding screen in section 3.3 for an explanation of the input data and Part II, sections 3.1 through 3.4, for greater detail of input data characteristics.

Access the Parameter Control Screen and select one data subgroup (by specifying a "Y"). At this point, do not specify any forecast years or forecast methods. Enter the required municipal data and data for your specified subgroup, save the file, select the Edit/Validate procedure, and then select the Run Model procedure. If errors occur during Edit/Validate or Run Model, recheck your input data. Use the Print/View procedure to review your output. When you have successfully generated a base year water use estimate with one subgroup, return to the Data Entry procedure and select an additional subgroup on the Parameter Control Screen. Then enter the data required for the additional subgroup and proceed with the error-checking procedure. Proceed with this step-by-step method until all desired subgroups have been addressed.

In order to generate water use estimates for each specified forecast year, you must (at the very minimum) provide population, median household income, and total employment to the internal growth models for each specified forecast year. Any additional methods will serve to improve the accuracy of the forecasted socioeconomic data in reflecting local area conditions and, therefore, will improve the accuracy of the water use forecasts. Data for forecast years are entered in the projection screens which are described in sections 3.4 through 3.6. These screens are available depending upon the forecast years and methods selected on the Parameter Control Screen.

Minimum data requirements for generating successful runs using the different forecast methods are listed in Table I-2. Once you have successfully generated a base year forecast, access the Parameter Control Screen and enter a forecast year(s) with only the internal growth models forecast method selected. Then enter the required data of the internal growth models for each specified forecast year. Save your file, select the Edit/Validate and Run Model procedures. If there are errors, go back to Data Entry and check your input. Use the Print/View procedure to check your output and note the number of parameter units projected for each subgroup. When you have successfully generated a forecast using the internal growth models, return to the Parameter Control Screen and specify an additional forecast method, either extrapolation from historical data or direct external projections. Enter the appropriate data for the additional forecast method and again save your file, select Edit/Validate, and Run Model. If there are errors, recheck your inputs. When the Run Model procedure is successfully completed, use the Print/View procedure to review your output and compare the projected parameter units with those generated by the internal growth models. It is up to you, the user, to judge the validity and reasonableness of the projected parameters generated by IWR-MAIN from the input provided.

Once an unrestricted water use forecast has been generated, return to the Parameter Control Screen and specify a "Y" for conservation. Use the F3 key to go directly to screen 15.1 and enter a year of initiation for one of the conservation measures. Then select at least one sector for that measure in screen 15.2. Be sure that the sector selected is one for which a water use forecast is being generated. Then specify "L" in both screens 16.1 and 17.1 so that all the reduction and coverage factors will be provided by IWR-MAIN. Save the file, select Edit/Validate, and Run Model. Use the Print/View procedure to review the output and observe the differences between the unrestricted and restricted forecasts. Use a text editor to print or view the file with the extension .COV in order to observe the coverage factors calculated by IWR-MAIN and the effectiveness of the measure. Now you can return to screens 16.1 and 17.1, specify "S" in each one, and experiment with different combinations of reduction factors and coverage factors and evaluate their impact on conservation effectiveness. The minimum data requirements for estimation of restricted water use are provided in Table I-3.

During the Edit/Validate and Run Model procedures, there are error-checking routines which check for input errors. However, these are not checks for the validity of the data. Table I-4 contains a list of internal crosschecks which you may follow in testing the soundness of your input data. When examining the rate of growth for a given parameter, you must be the judge of what is reasonable growth for the given parameter and time interval for your study area. Remember that the direct external projection data entered in screens 14.x.1 through 14.x.9 take precedence over the other parameter projection methods and thus may be used to control the growth of a given parameter.

TABLE I-1

MINIMUM DATA REQUIREMENTS FOR ESTIMATION OF BASE YEAR UNRESTRICTED WATER USE

Sector/ Subgroup	Screen	Data	Comments
MUNICIPAL	1.1	-calendar year of base year -latitude of study area -longitude of study area -resident population -median household income -total base year employment -employment 5 years before base year -composite construction cost index	Municipal data are required regardless of subgroup selection in the Parameter Control Screen.
RESIDENTIAL			Select any or all residential subgroups in the Parameter Control Screen and provide input for selected subgroup(s) as follows:
Flat rate and sewered	2.1	-low and high value range -persons per unit -units per acre -number of units	Select "flat rate and sewered" in the Parameter Control Screen. Specify value ranges and enter data for each value range.
Flat rate and unsewered	3.1	-low and high value range -persons per unit -units per acre -number of units	Select "flat rate and unsewered" in the Parameter Control Screen. Specify value ranges and enter data for each value range.
Metered and sewered	4.1	-low and high value range -annual marginal price -summer marginal price -units per acre -number of units -annual bill difference -summer bill difference	Select "metered and sewered" in the Parameter Control Screen. Specify value ranges and enter data for each value range.
Master metered apartment	5.1	-low and high value range -persons per unit -number of units	Select "master metered apartments" in the Parameter Control Screen. Specify value ranges and enter data for each value range.

TABLE I-1 (Continued)

Sector/ Subgroup	Screen	Data	Comments
COMMERCIAL	6.1	-employment by category	Select "commercial" in the Parameter Control Screen. Commercial sector data may be input in one of two ways: (1) specify employment for at least one category in screen 6.1 or (2) create at least one category in screen 6.2. If screen 6.1 is not used, one category in screen 6.2 may represent the entire commercial sector. If employment is provided for some, but not all, categories in screen 6.1, categories created in screen 6.2 may represent the remainder of the sector. Note that employment specified in screen 6.1 uses water use coefficients stored in the library file while water use coefficients must be supplied for any category created in screen 6.2.
	6.2	-category description -category employment or both number of units and unit parameter -annual average water use -maximum-day water use	
INDUSTRIAL	7.1-7.6	-employment by either three-digit or four-digit SIC code	Select "industrial" in the Parameter Control Screen. Industrial sector data may be entered in one of two ways: (1) specify employment for at least one category in screens 7.1-7.6 or (2) create one or two categories in screen 7.7 which represent the entire sector. Employment specified in screens 7.1-7.6 uses water use coefficients in the library file while water use coefficients must be supplied for any category created in screen 7.7.
	7.7	-category description -category employment -annual average water use -maximum-day water use	
PUBLIC/UNACCOUNTED	8.1	-population served by system -annual average distribution losses -maximum-day distribution losses -annual average free service -maximum-day free service	Even without "public/unaccounted" selected in the Parameter Control Screen, IWR-MAIN will generate a forecast of distribution losses and free service water use using default values and the required municipal data. To override the default calculations, select "public/unaccounted" in the Parameter Control Screen and enter data in screen 8.1. For distribution losses, enter in population served by the system for a per capita calculation, or enter both annual average and maximum-day water use. To specify free service, enter both annual average and maximum-day free service. Additional public water use categories may be created by entering all the data for a category in screen 8.2.
	8.2	-category description -number of units -unit parameter -annual average water use -maximum-day water use	

TABLE I-2

MINIMUM DATA REQUIREMENTS FOR ESTIMATION OF FORECAST YEAR UNRESTRICTED WATER USE

Forecast Method	Screen	Data	Comments
INTERNAL GROWTH MODELS	9.1	-population -median household income -employment	These data are required for any forecast year listed in the Parameter Control Screen, even if forecast method "1" is not specified.
(Options)	9.1	-number of households -percent household in income groups	If percent households in income group is used, similar data must be provided for the base year in screen 1.2.
(Options)	9.3	-employment by industry group	If used, similar data must be provided for the same group(s) for the base year and 5 years prior in screen 1.2.
EXTRAPOLATION OF HISTORICAL DATA --OPTIONAL			
	10.1-10.2	-historical years -number of housing units by subgroup and range	Specify forecast method "2" in the Parameter Control Screen beside the forecast year(s) for which this method is to be used. Enter residential, commercial, industrial, or public/unaccounted data. Base year data must have been entered for whichever sector(s) forecasts are to be generated. For residential data, enter at least two historical years for any residential subgroup in screen 10.1 or 10.2 and enter the number of units for at least one range group for those years. For commercial or industrial data, enter at least two historical years in screen 11.1 or 12.1, respectively. Categories specified in the base year will be highlighted; enter the historical employment for any highlighted category for the historical year entered. For public/unaccounted data, enter at least two historical years in screen 13.1. Enter historical population for distribution losses or free service for the years specified. If any user-added public categories were specified in screen 8.2, you may enter historical parameter values for those historical years.
	11.1-11.4	-historical years -commercial category empl.	
	12.1-12.a	-historical years -industrial category empl.	
	13.1-13.2	-historical years -population served for distribution losses (LOSS) and free service (FSER) -category parameter for user-added categories	

TABLE I-2 (Continued)

Forecast Method	Screen	Data	Comments
DIRECT EXTERNAL PROJECTIONS -OPTIONAL			
	14.x.1	-number of housing units by subgroup and range	Specify forecast method "3" in the Parameter Control Screen beside the forecast year(s) for which direct external projections are available. Be sure that sector(s) have been selected in the Parameter Control Screen and that base year data have been entered for each sector for which external projections are being provided. Screens 14.x.1-14.x.9 are repeated for each forecast year for which "3" is specified in the Parameter Control Screen. The "x" in the screen number refers to the forecast year. Enter the projected number of housing units for any residential subgroup and value range combination for the residential sector. For the commercial sector, enter employment projections for any of the C001-C023 categories used in the base year and parameter projections for any user-added categories. Enter projected employment for any industrial category used in the base year for the industrial sector. Projections for the public/unaccounted sector may be entered in a number of ways. Projected distribution losses may be entered as (1) a fractional percent (e.g., 0.15) of total municipal water use, (2) as projected population for a per capita calculation, or (3) as projected annual average and maximum-day losses in gallons per day. Projected free service water use data may be entered as the projected population for a per capita calculation or as projected annual average and maximum-day water use in gallons per day. Projected data for user-added public categories may be entered as the projected parameter value or as the annual average and maximum-day water use in gallons per day.
	14.x.2-	-commercial category empl.	
	14.x.3	-commercial category parameter	
	14.x.4-14.x.7	-industrial category empl.	
	14.x.8-14.x.9	-population for distribution loss (LOSS) -annual average distribution loss -maximum-day distribution loss -population for free service (FSER) -annual average free service -maximum-day free service -number of parameter units for user-added public categories -average annual water use -maximum-day water use -fractional percent distribution loss (FLSS)	

TABLE I-3

MINIMUM DATA REQUIREMENTS FOR ESTIMATION OF RESTRICTED WATER USE

Screen	Data	Comments
15.1	-year of initiation of conservation measure(s)	Select "conservation" in the Parameter Control Screen in order to access the conservation screens. Select a conservation measure in screen 15.1 by entering a year of initiation for that measure. The year may be before, equal to, or after the base year. Indicate in screen 15.2 which sector(s) are affected by the conservation measure selected in screen 15.1. The description of measures in Part II, section 4.3, indicates the sectors which may be appropriately used with each measure.
15.2	-sectors affected by measure	
16.1	-specification of reduction factors	Specify "L" in screen 16.1 to use the default reduction factors for the selected measures and sectors. Specification of "S" will provide access to screens 16.2-16.4 and will allow you to specify some or all reduction factors. If some, but not all, reduction factors are provided in screens 16.2-16.4, the default factors will be used for those not provided.
16.2 (optional)	-indoor use reduction factors by measure and sector	
16.3 (optional)	-outdoor use reduction factors by measure and sector	
16.4 (optional)	-maximum-day use reduction factor by measure and sector	
17.1	-specification of coverage factors	Specify "L" in screen 17.1 to have the coverage factors calculated by IWR-MAIN using default coefficients. Specification of "S" will provide access to one coverage factor screen for each year beginning with screen 17.2 for the base year. Any coverage factors not provided in screens 17.2-17.x will be calculated using default values.
17.2-17.x (optional)	-coverage factors by year, measure, and sector	

TABLE I-4

INTERNAL CROSSCHECKS FOR INPUT DATA

Screen Number	Parameter	Crosscheck
1.2	-employment--base year and five years prior	If employment for all eight groups is provided, sums should equal total employment (base year and five years prior) in screen 1.1.
6.1 and 6.2	-commercial employment	Sum of commercial employment should equal base year employment minus SIC 2000-3999 employment in screen 1.2.
7.1-7.7	-industrial employment	Sum of industrial employment should equal SIC 2000-3999 employment in screen 1.2.
9.1	-projected population, income, and employment	Should be compared to values in screen 1.1 for rate of growth.
	-projected total households	Should be compared to sum of number of units in screens 2.1 through 5.1 for rate of growth.
9.3	-projected employment by group	Sum for each year should equal projected employment in screen 9.1.
		Projected group employment should be compared to corresponding values in screen 1.2 for rate of growth.
10.1 and 10.2	-historical housing	If provided, housing by value range groups should be compared to base year number of units in corresponding value ranges in screens 2.1 through 5.1 for rate of growth.
11.1-12.a	-historical commercial and industrial employment by category	Should be compared to base year employment for corresponding categories in screens 6.1 through 7.7 for rate of growth.
13.1 and 13.2	-historical public/unaccounted parameters	Should be compared to corresponding base year parameters in screens 8.1 and 8.2 for rate of growth.
14.x.1	-externally projected housing by value range group	Should be compared to number of base year units in corresponding value ranges in screens 2.1 through 5.1, or projected values in previous forecast years, for rate of growth.
		If provided, totals for each housing type should sum to total projected housing for the forecast year in screen 9.1

TABLE I-4 (Continued)

Screen Number	Parameter	Crosscheck
14.x.2 and 14.x.3	-externally projected commercial employment or parameter	Should be compared to corresponding category employment (or parameter) in base year in screens 6.1 and 6.2, or projected values in preceding forecast year, for rate of growth. Sum of employment should not exceed total employment for forecast year in screen 9.1 minus employment for SIC 2000-3999 in screen 9.3.
14.x.4-14.x.7	-externally projected industrial employment	Should be compared to corresponding category employment in screens 7.1 through 7.7, or projected values in preceding forecast year, for rate of growth. Sum of employment should not exceed employment for forecast year for SIC 2000-3999 in screen 9.3.
14.x.8	-externally projected public/ unaccounted parameters	Should be compared to parameters in base year in screens 8.1 and 8.2, or projected values in preceding forecast year, for rate of growth.
15.2	-sector selection for conservation measures	Selected sectors should be consistent with definition of the conservation measure.
16.2-16.4	-reduction factors for conservation measures	Water use dimension for which a reduction factor is specified should be consistent with definition of the conservation measure Zero (0.000) generates no reduction in water use for that measure, dimension, and sector while one (1.000) allows maximum reduction in water use.
17.2-17.x	-coverage factors for conservation measures	Compare coverage factors for same measure and sector across time for shifts in compliance. Zero (0.000) generates no reduction in water use for that measure, sector, and year while one (1.000) allows maximum reduction in water use.

9. QUICK REFERENCE

IWR-MAIN WATER USE FORECASTING SYSTEM

PART II

SYSTEM DESCRIPTION AND PROCEDURES

1. INTRODUCTION

Using a step-by-step approach, Part I presents a "User's Manual" of the IWR-MAIN System, guiding the user through the operation of the system. Alternately, Part II provides a more detailed description of the IWR-MAIN System.

Chapter 2 presents an overview of the most widely used water use forecasting approaches and then briefly presents the approaches used by the IWR-MAIN System. Chapter 3 describes, in detail, the input data requirements and options and then continues with a presentation of available data sources. Chapter 4 presents the methods used by IWR-MAIN to compute unrestricted and restricted water use. Also in chapter 4 is a discussion of the three parameter projection methods and the structure of the IWR-MAIN libraries. In some applications of IWR-MAIN, the user may wish to verify the IWR-MAIN estimates and, if necessary, perform calibrations. Chapter 5 discusses why discrepancies may exist, how to verify estimates, and how to perform calibrations.

Part II is intended to provide the user with a conceptual and methodological understanding of the IWR-MAIN Water Use Forecasting System. The use of this "System Description," along with the "User's Manual," will allow users to effectively apply IWR-MAIN to various planning situations.

2. CONCEPTUAL AND ORGANIZATIONAL STRUCTURE

2.1 DETERMINANTS OF WATER DEMAND

The level and pattern of municipal water use (both spatial and temporal) are determined by demographic, socioeconomic, and climatic characteristics of the water service area. These may include:

(1) Resident and seasonal population
(2) Number, market value, and types of housing units
(3) Employment in service industries
(4) Manufacturing employment and output
(5) Water and wastewater prices and rate structures
(6) Irrigated acreage in residential and commercial/institutional use
(7) Personal income
(8) Climate (i.e., arid or humid)
(9) Weather conditions
(10) Water-using appliances
(11) Conservation activities

The forecasts of future water requirements and use are linked to the future values of these water use determinants. The latter may be projected by any number of methods, depending on data and other available information. These methods include the use of judgment, consensus, simple extrapolation, shift-share analyses, multiple regression methods, simulation models, and other techniques.

Water use forecasting methods translate projected values of one or more of the above explanatory variables into future water use. Available forecasting methods make various assumptions regarding the number and type of explanatory variables, the nature of the relationship between explanatory variables and water use, and the way in which that relationship may change over time. Several methods of water use forecasting are discussed in the following section. This discussion is based, in part, on the work of C. Vaughan Jones et al. Following the discussion of water use forecasting approaches is a description of the organizational structure of the IWR-MAIN Water Use Forecasting System.

2.2 WATER USE FORECASTING APPROACHES

Time Extrapolation

Time extrapolation of water use data is based on the assumption that future water use is determined by water use trends in the past; no other data or information need be considered. Usually, the change in water use over time is extrapolated into the future. The extrapolation may be accomplished by graphical or mathematical means, and the change over time may be assumed to follow a linear, logistic, exponential, or other function.

Single Coefficient Requirements Methods

The per capita requirements approach estimates future water use as the product of projected service area population and a projected value of per capita water use. Future service area population is determined using one of the methods mentioned above. The per capita water use coefficient may be assumed to be fixed over time or may itself be the subject of a projection. Its value and, where applicable, rate of change may be determined from past water use patterns in the study area, from data for other areas, or from national data. The coefficient value may also be obtained from reference works, or it may simply be assumed.

A variant of the per capita requirements approach is the per customer (or per connection) requirements method, which substitutes the number of customers for the resident population. This reflects the empirical fact that water use is better correlated with number of customers than with population served. Per customer methods are most frequently used in conjunction with sectorally disaggregate forecasts, where they may be applied to nonresidential sectors.

Other single coefficient methods are in common use, based on a range of parameters. Industrial water use is commonly forecast on a per employee basis, for example, while specific categories of commercial and industrial water use are frequently expressed as a (single coefficient) function of other variables, such as number of hospital beds, hotel rooms, etc. A recent study of water use at military installations used single coefficient methods to express water use for each of a number of use categories as a function of the floor area of buildings in that category (Langowski, 1984).

Multiple Coefficient Requirements Models

Future water use, either aggregate or sectoral, can be expressed as a mathematical function of two or more explanatory variables. The functional form is chosen to provide an acceptable fit of the model to historic data, and the coefficients are estimated statistically, usually by multiple regression analysis. Models which do not include the price of water, or other economic factors, as an explanatory variable are known as requirements models (since they imply that water use is an absolute requirement, unaffected by economic choice). The variables are chosen because of past correlation with water use, and any number may be included, although more than five or six is unusual. Multiple coefficient models used in forecasting may have been estimated from historic data for the same study area, or they may be based on data for one or more other study areas, a larger region, or the nation.

Multiple Coefficient Demand Models

Multiple coefficient demand models differ from multiple coefficient requirements models in one key respect: demand models include the price of water to the user, as well as related economic variables such as income, among the explanatory variables. Also, demand models are usually constructed according to econometric methods, where the structure of the model and the list of potential explanatory variables reflect assumptions regarding causality, rather than simply arising from observed correlation. The possibility of improperly included or specified variables is, therefore, reduced. Attention is usually given to supplying as complete a set of explanatory variables as possible, thus minimizing the unexplained variance in the dependent variable (water use).

Disaggregated Water Use Forecasts

Disaggregated water use forecasting separately specifies water use for each sector, season, or region, utilizing the best available model for each type of water use. This method permits the use of explanatory variables unique to a given type of water use and generally yields a more accurate composite forecast.

2.3 IWR-MAIN WATER USE SYSTEM OVERVIEW

IWR-MAIN is a computerized water use forecasting system which contains a range of forecasting models, socioeconomic parameter-generating procedures, and data management techniques. Among its major features are a high level of disaggregation of water use categories and considerable user flexibility in selecting forecast methods and assumptions. Because of the level of disaggregation, the system is able to reflect water use differences between communities with different types of water-using activities.

Forecasting and Estimating Methods of IWR-MAIN

The IWR-MAIN System divides urban water users into four major sectors: residential, commercial/institutional, industrial, and public/unaccounted. Each sector is further disaggregated to a number of categories for forecasting purposes. A maximum of 380 categories can be accommodated, but most forecasts utilize approximately 130 specific categories of water use.

A mixture of water use estimating techniques is employed in the computational subroutines of IWR-MAIN (see Table II-1). For some user sectors, water use is estimated by means of econometric demand models containing a number of explanatory variables (including price in the case of residential users with water meters). Other uses are predicted by means of requirements models, usually of the unit use coefficient type. The original form of the IWR-MAIN System used demand models adapted from the work of Howe and Linaweaver (1967). Some of these have been replaced with results from later work by Howe (1982) (see example in Table II-2). Commercial/institutional and industrial customer sectors are disaggregated by three- and four-digit Standard Industrial Classification (SIC) categories. Unit use coefficients (per employee) are assigned to each commercial and industrial category (e.g., Table II-3).

In each time period, water use is calculated as a function of a set of parameters, or explanatory variables. Each of these parameters must be projected to the forecast year for which water use is to be estimated. IWR-MAIN provides three alternative approaches for projecting future values of the determinants of water use:

(1) Projection by internal growth models
(2) Projection by extrapolation of local historic data provided by the user
(3) Use of projections made external to the IWR-MAIN System, as provided by the user

Any of the three methods can be used for any given parameter and for any forecast year, independent of methods used for other parameters or for other forecast years. See Figure II-1 for a graphic representation of IWR-MAIN and its forecasting options.

Conservation Effectiveness

The conservation subroutine of the IWR-MAIN System contains 14 specified conservation measures and four additional measures which may be user-specified. As a result of this option, IWR-MAIN is able to produce estimates of future water use both with (restricted water use) and without (unrestricted water use) the effects of municipal water conservation measures.

The water conservation effectiveness algorithm was developed which utilizes estimates of (1) the percent reduction in water use attributable to a given water conservation measure in a given municipal sector; (2) the coverage (or compliance) of a given measure in a given sector; and (3) the effectiveness or expected reduction in water use for a given measure calculated as the product of the above two quantities and the unrestricted water use estimate for a given sector:

$$E_{msdt} = R_{msd} * C_{mst} * Q_{std}$$

where

E_{msdt} = the effectiveness of measure m in water use dimension d(e.g., indoor use) in sector s (e.g., multifamily residential) at time t (e.g., 1990)
R_{msd} = the reduction of measure m in sector s and dimension d
C_{mst} = the coverage of measure m in sector s in time t
Q_{std} = the unrestricted water use projected for sector s in time t and dimension d

For conservation purposes, the dimensions of water use are indoor, outdoor, and maximum-day use.

When more than one conservation measure is selected for a given municipal sector, the algorithm accounts for possible interactions of measures before providing the estimate of water use as restricted by the conservation measures.

Past Applications

During the original development of the system, IWR-MAIN was used to "backcast" water use--that is, to estimate past water use based on known values of predictor parameters for that time period--for a number of communities. Table II-4 summarizes the results of these early experiences, together with four more recent results of the IWR-MAIN System. These results show a rather close agreement between predicted and actual levels of water use, especially for larger cities. Errors in estimates of aggregate water use range from 0.3 to 3.1 percent for six areas with annual water use of more than 3.0 million gallons per day (mgd). The smaller areas showed errors in the 3.2 to 8.4 percent range. It should be noted that no water use data are required to use the IWR-MAIN System--backcasts were based entirely on demographic and socioeconomic data and did not involve calibration of the water use models, except for the three most recent studies in Table II-4 which used some coefficients calculated from local data. Still IWR-MAIN successfully reproduced water use in areas with per capita use rates ranging from 70 to 250 gallons per person per day.

FIGURE II-1

IWR-MAIN SYSTEM AND FORECASTING OPTIONS

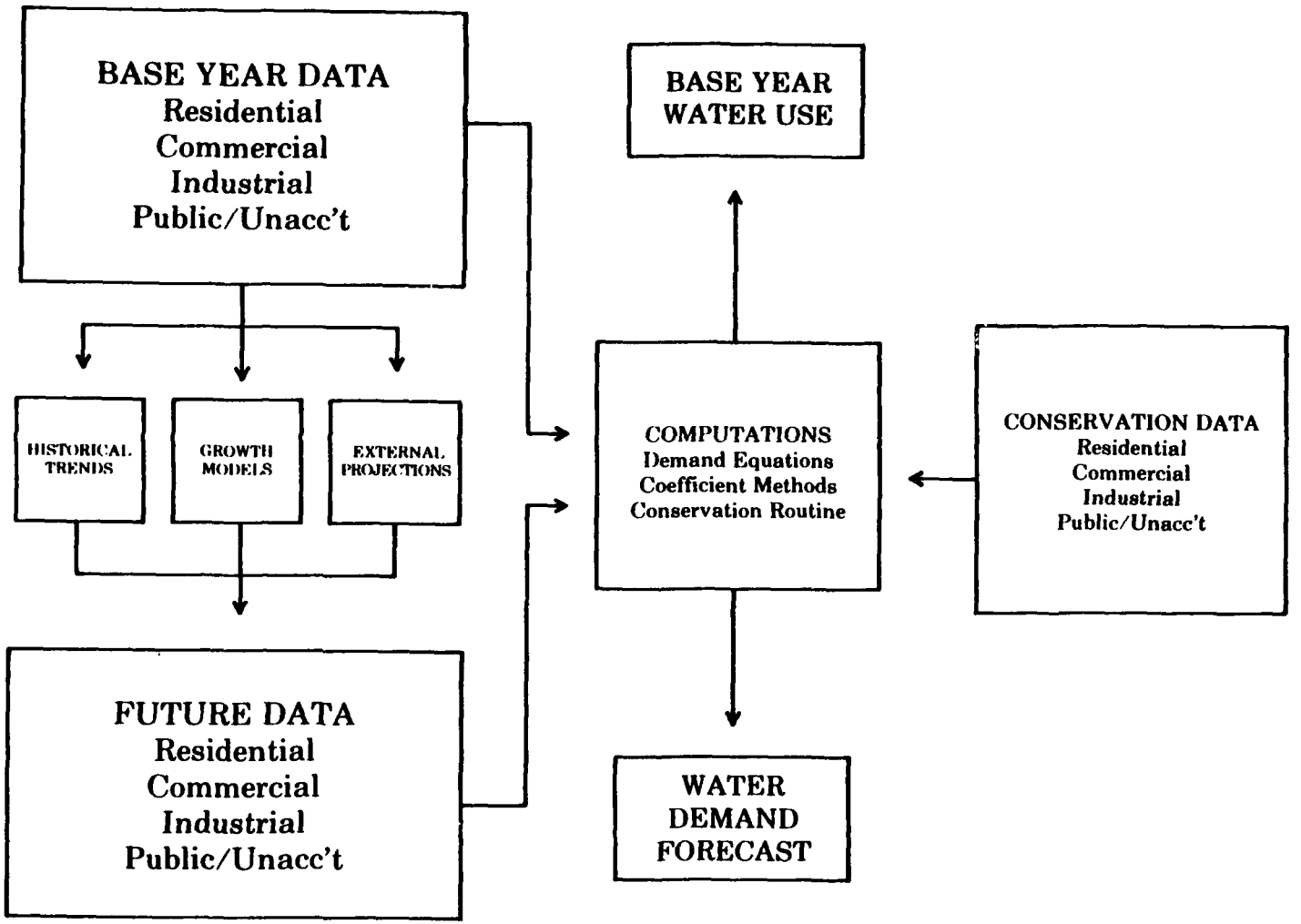


TABLE II-1

ORGANIZATION OF THE IWR-MAIN SYSTEM

Sector	Water Use Category	Forecast Method
Residential	Metered and sewered residences Flat rate and sewered residences Flat rate and unsewered residences Master-metered apartments	Econometric demand models Mult. coef. rqrmts. models Mult. coef. rqrmts. models Mult. coef. rqrmts. models
Commercial/ Institutional	Up to 50 user categories, including 23 categories defined as groups of four-digit SIC codes	Unit use coefficients (per employee)
Industrial	Up to 200 user categories, including 198 manufacturing categories defined by three-digit and four-digit SIC codes	Unit use coefficients (per employee)
Public/ Unaccounted	Up to 30 user categories, such as distribution system losses and free service	Unit use coefficients or per capita requirements

TABLE II-2

EXAMPLE OF ECONOMETRIC DEMAND MODEL

Mean Sprinkling Use for Metered and Sewered Residences in United States, East of 100th Meridan

$$Q = (385.0 + 2.876\ V - 285.8\ P_s - 4.35\ I_s + 157.77*B*MD)N_r$$

where

- Q = mean summer water use for category, gallons per day
- V = median market value for residence within specified value range, $1,000
- P_s = marginal price of water in summer, dollars per 1,000 gallons
- I_s = effective summer bill difference variable, dollars per billing period
- B = irrigable land per dwelling unit, acres per unit
- MD = summer season moisture deficit, inches
- N_r = number of residences in value range

TABLE II-3

EXAMPLE OF UNIT USE COEFFICIENT

Mean Annual Water Use for Commercial/Institutional Category CO16
(Schools & Universities)

$$Q = C * P$$

where

Q = mean annual water use for category, gallons per day

C = water use coefficient for schools, gallons per day per employee (current value - 35.7 gallons per day per employee)

P = employment in SIC codes 8211 through 8229 (Category C016)

TABLE II-4

BACKCASTS PERFORMED WITH THE IWR-MAIN SYSTEM

Year of Data	Location	Sector	Utility Records (mgd)	IWR-MAIN Estimate (mgd)
1963	Baltimore, MD	Residential	97.3	95.2
		Public/commercial	19.6	19.2
		Industrial	42.0	45.1
		TOTAL	158.9	159.5
1963	Park Forest, IL	Residential	1.7	1.6
		Commercial	0.2	0.2
		TOTAL	1.9	1.8
1965	Baton Rouge, LA	Residential	n/a	14.0
		Commercial/industrial	n/a	5.2
		Public & unaccounted	n/a	4.4
		TOTAL	23.8	23.6
1965	Park Forest, IL	Residential	1.9	1.8
		Commercial	0.2	0.2
		TOTAL	2.1	1.9
1967	Park Forest, IL	Residential	1.9	1.8
		Commercial	0.2	0.2
		TOTAL	2.0	2.0
1968	Anne Arundel Co., MD (Kings Heights Dist.)	Residential/commercial	0.3	0.3
1980	Chester, PA	Residential	5.0	7.5
		Commercial/inst.	1.5	3.2
		Industrial	12.0	11.1
		Public & unaccounted	5.2	2.1
		TOTAL	23.7	23.9
1984	Indianapolis, IN	Residential	46.5	46.5
		Nonresidential	37.8	40.4
		TOTAL	84.3	86.9
1984	Phoenix, AZ	Residential	152.9	152.4
		Commercial/inst.	50.7	50.8
		Industrial	11.8	12.0
		Public/unaccounted	6.6	9.0
1985	Springfield, IL	Residential	-	10.2
		Commercial/inst.	-	4.5
		Industrial	-	0.8
		TOTAL	15.1	15.5

3. INPUT DATA CHARACTERISTICS

Two kinds of data are required to use the IWR-MAIN System: (1) actual values of demographic and socioeconomic determinants (or parameters) of water use for the base year and (2) projected values of selected parameters for each specified forecast year. If the conservation algorithm is used, information regarding the implementation of conservation measures must be provided. IWR-MAIN is designed to accommodate a variable degree of data availability. Therefore, the amount of time and effort required to prepare a forecast depends on the level of disaggregation of the water use sectors, the level of detail in the input data, and the size of the study area.

The following sections present the input data requirements and characteristics of the IWR-MAIN System (version 5.1). Also included is a list of possible sources for these input data. The data are entered through the IWR-MAIN Data Entry screens and converted into a structured ASCII .DAT file used in the IWR-MAIN Run Model procedure. In order to provide a cross-reference between the data entered through the Data Entry screens and the converted data labels appearing in the .DAT file, a description and cross-reference table is included in Appendix C.

3.1 BASE YEAR DATA

Base year data are used to estimate current water requirements and also serve as a reference point for projections of future parameters. If necessary, associated base year water use estimates may also be used to calibrate the computational equations or coefficients to localized conditions (see chapter 5).

There are four major municipal sectors addressed by the IWR-MAIN System: residential, commercial/institutional, industrial, and public/unaccounted. For the base year it is also necessary to provide data describing general study area characteristics. See Figure II-2 for a graphic display of the relationship between the base year input data and the water use estimates that are obtained.

General Municipal Identification Data

Some of the input data provided for this subgroup are used by IWR-MAIN as identification information for the output displays, while other parameters are needed for computations, parameter projections, and system control. The first piece of identification information is the name of the study area. This is entered on the Parameter Control Screen. Several examples include:

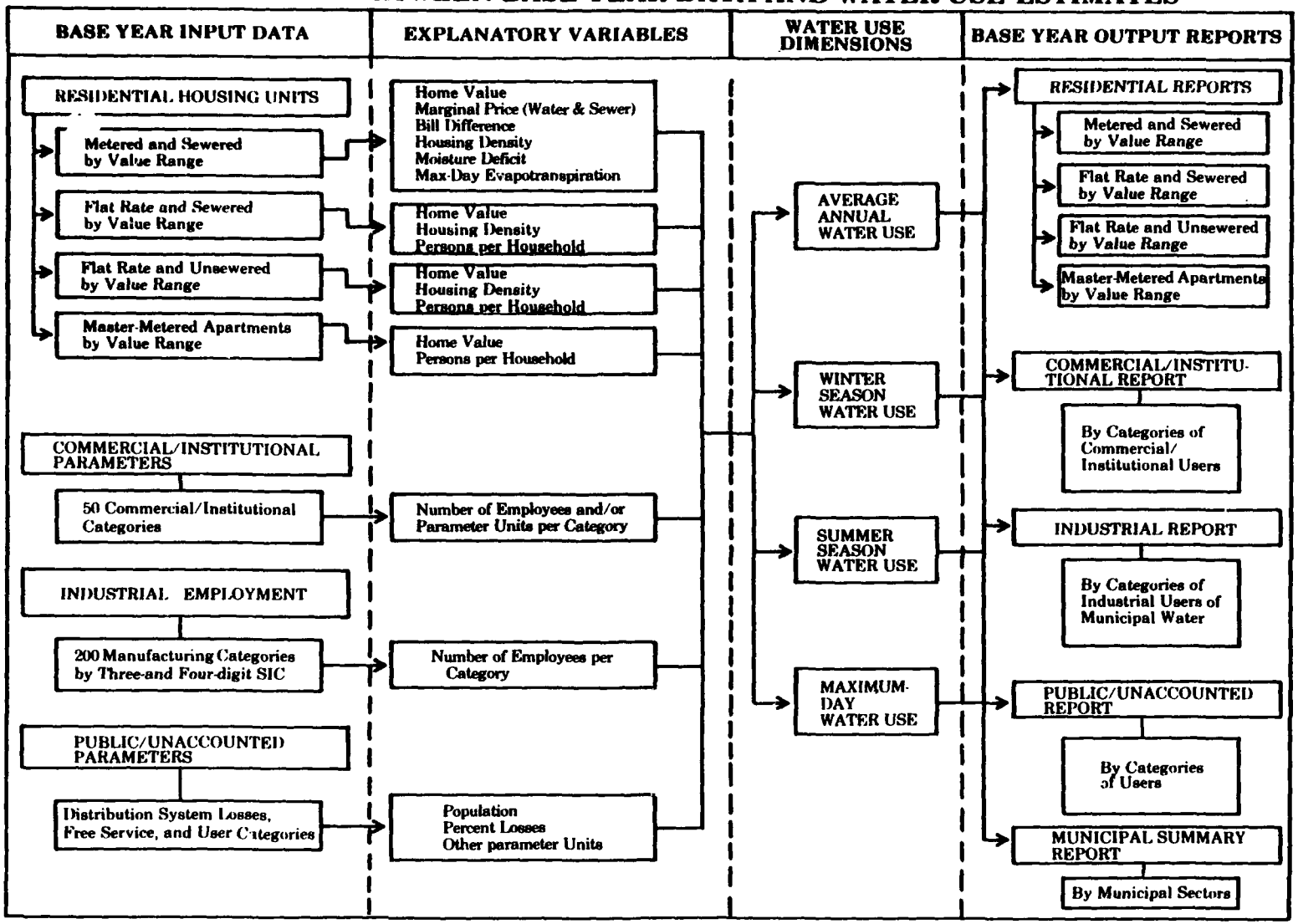
Los Angeles (Burbank)
Chicago, IL
Austin, Texas

General municipal identification data may be either required or optional and are entered on Data Entry screens 1.1 and 1.2. These data include:

(1) Data to include central city? -- a value of one (1) indicates that the central business district is included within the study area; a blank or a zero indicates that it is not.
(2) .PRN file requested? -- supplying this variable with a value of one causes the results of water use estimates to be written to an external file with the extension (.PRN). This file can be read by spreadsheet and data base programs (optional).
(3) Calendar year of base year -- calendar year of base year parameter values.
(4) Latitude and longitude -- study area latitude and longitude (in degrees). These values are required by the system to extract climatic data from the Library of Climatic Variables.
(5) Resident population -- population of the study area in the base year. This value is required for all forecasts and may be used for the computation of public/unaccounted requirements.

FIGURE II-2

RELATIONSHIP BETWEEN BASE YEAR DATA AND WATER USE ESTIMATES



(6) Median household income -- median household income for the study area, expressed in 1980 dollars.

(7) Total base year employment -- total study area employment (except agricul re, forestry, fishing, and mining) in the base year. This value is required for all forecasts and includes reported employment by firms or individuals located within the study area, without respect to location of the residences of those employed.

(8) Total employment 5 years before -- total study area employment (except agriculture, forestry, fishing, and mining) five years before the base year.

(9) Department of Commerce National Composite Construction Cost Index -- base year construction cost index adjusts home value to 1980 priee levels prior to computation of residential water requirements. If this value is not provided, the alternative (CCAL and CCBL) must be used. The 1980 value is 143.3 (where 1977 = 100).

(10) Alternative Construction Cost Index [CCAL and CCBL] -- alternative cost index. Values must be supplied for 1980 (CCAL) and the base year (CCBL).

(11) Evapotranspiration and precipitation -- values for summer season potential evapotranspiration (inches) and summer season precipitation (inches). Although seasons may vary by region, the summer season is most commonly defined as June, July, and August. When provided, the "normal" values are used to calculate the summer season moisture deficit which is used in the estimation of residential water use. The Library of Climatic Variables is read if one of these values is present and if the moisture deficit is not provided. When provided, the "actual" values are used to calculate the actual moisture deficit for calibration of the residential metered and sewered summer water use as described in section 5.3. The "actual" values should be deleted prior to a final forecast run (optional).

(12) Maximum-day potential evapotranspiration -- value for potential evapotranspiration during the 24-hour period with the highest water use of the year. When provided, this value (in inches) is used in place of the default value in the calculation of maximum-day sprinkling water use for metered and sewered housing (optional).

(13) Moisture deficit -- summer season moisture deficit in inches. When provided, the "normal" value is used in the calculation of summer water use in areas east of the 100th meridian. It overrides the use of Library of Climatic Variables and user-supplied climatic data (optional). The "actual" value, when provided, is used to calibrate a forecast for actual weather conditions in a specific calibration year. See Part II, section 5.3, for details.

(14) Fraction of households with base year income: (<$10,000); ($10,000-$20,000); ($20,000-$30,000) -- fraction of households with base year income, measured in 1980 dollars, in respective value ranges (optional).

(15) Employment by sector -- construction (SIC 1500-1799); manufacturing (SIC 2000-3999); transportation, communication, and utilities (SIC 4000-4999); wholesale trade (SIC 5000-5199); retail trade (SIC 5200-5999); finance and banking (SIC 6000-6799); services (SIC 7000-8999); and government (SIC 9100-9799), for base year and five years prior. All values are not required; but both base year and five years prior values are required for each sector specified (optional).

Residential Data

Current data describing the residential sector of a study area may be prepared and entered under any of the four residential housing types: flat rate and sewered (data screens 2.1 and 2.2); flat rate and unsewered (data screens 3.1 and 3.2); metered and sewered (data screens 4.1 and 4.2); and master-metered apartments (data screens 5.1 and 5.2). Each housing type represents a major subgroup in the IWR-MAIN System and is described below.

(1) Flat rate and sewered -- includes housing units that do not face a charge which varies with quantity of water used: those that pay a flat rate for water/wastewater services or are renter-occupied where the owner pays the water/wastewater bill. Such customers, therefore, face a zero marginal price and are not expected to react to changes in price. This category may also include housing units contained in buildings with two or three units per structure and mobile home parks where a single meter serves all units. All units in this category are served by a public sewer system.

(2) Flat rate and unsewered -- includes housing units similar to the above category except that customers are not served by a public sewer system. Wastewater disposal is, therefore, by means of a private septic tank, cesspool, or other method.

(3) Metered and sewered -- includes single-family housing units that are individually metered and are served by a public sewer system. These housing units are considered owner-occupied or occupied by renters who are responsible for paying the water and wastewater bill.

(4) Master-metered apartments -- includes housing units located in structures with four or more units. The structure may be unmetered or provided with a single (master) meter. Individual housing units face a zero marginal price of water and have little opportunity to engage in outdoor (seasonal) water use.

All subgroups need not be addressed; however, each subgroup has certain data requirements (see Table II-5). Based on these data, IWR-MAIN estimates winter, summer, average annual, and maximum-day water use using internal multiple coefficient computational equations. The residential input data parameters include:

(1) Value ranges (low and high) -- lower and upper limits, respectively, of a property value range, expressed in ($100s) at base year price levels. These values represent either market value or assessed value, provided there is a known and reasonably consistent relationship between assessed and market values.

(2) Persons (no./unit) -- population density expressed in average number of persons per housing unit. A different value may be used for each value range, if suitable data are available. This value is required for all residential subgroups except metered and sewered.

(3) Density (units/acre) -- housing density expressed in dwelling units per gross acre, including streets and driveways. This value may be different for each value range. It is not required for master-metered apartments. Typical housing density values range from approximately 1.25 to 9.5 units per acre with a mean of about 4.0.

(4) Price of water (annual and summer) -- annual and summer marginal price of water, including any charges billed as a percentage of water price or as a function of water use. Annual marginal price is estimated by averaging, over all billing periods, the price in effect for the last units of water used plus any wastewater charges or other surcharges. Summer marginal price is estimated by averaging incremental charges over the April-September period. Marginal prices are calculated from base year rate schedules but expressed in 1980 dollars. Marginal prices may differ from one value range to another and should reflect expected water use levels (annual and summer). These values are only required for metered and sewered housing.

(5) Bill difference (annual and summer) -- annual and summer bill difference variables. The bill difference variable captures the effects of changes in consumers' residual income caused by increased or decreased water bills as a result of changes in rate designs. Bill difference is calculated as the difference between the actual total water bill and a hypothetical bill defined as the product of the quantity consumed and the effective marginal price. The result is expressed in dollars per billing period. Since this calculation, like that for marginal price, requires knowledge of winter and summer water use, it may be recursive in nature: an IWR-MAIN run can be made using approximate values for annual and summer marginal prices and bill difference variables. This generates a per customer water use estimate for each value range which can be used to recalculate the marginal prices and bill difference variables for the next run. These variables are required only for metered and sewered units and are calculated from base year rate structures but expressed in 1980 dollars.

(6) Assessment factor -- ratio of assessed value to current market value. This value must be provided when value ranges are expressed in terms of assessed, rather than market, value. The default value is one (1). A different value for each value range may be used, provided suitable data are available.

Up to 25 value ranges may be used within each residential subgroup. Due to the sensitivity of the residential water use requirements to home value, it is recommended that no individual value range be larger than necessary, preferably less than $10,000 from low to high.

Commercial/Institutional Data

The IWR-MAIN System includes 23 built-in commercial/institutional categories to estimate water requirements for this sector [C001-C023]. These categories are designed to account for all urban nonmanufacturing employment (they do not include most forms of agricultural, forestry, fishing, or mining employment) and are organized as combinations of Standard Industrial Classification (SIC) groups. See Tables II-6 and II-7 for a listing and cross-reference of commercial and institutional categories. Commercial employment is entered in data screen 6.1. If local conditions require the consideration of additional categories of water use, or if specially defined categories are to be used in place of those provided, the user can define up to 27 additional commercial/institutional categories. This requires that the user specify the necessary information using data screens 6.2 and 6.3.

When using the additional user-specified commercial categories [C024-C050], parameters other than employment can be used to estimate water use, provided that the water use coefficients are supplied. In the case of the 23 built-in categories, IWR-MAIN multiplies water use coefficients contained in the Library of Water Use Coefficients by the employment provided for a specific [C0xx] category.

If the price difference adjustment for the commercial sector is to be used, the marginal water price for the commercial sector in both the base year and the year concurrent with the commercial water use coefficients must be entered in data screen 7.7. Prices are entered as dollars per 1,000 gallons in 1980 dollars.

Industrial Data

Water use in the industrial sector is also estimated based on the per employee water use coefficients contained in the IWR-MAIN Library of Water Use Coefficients. Manufacturing employment, disaggregated by SIC codes, may be assigned to a possible 198 industrial categories as shown in Table II-8. These employment data are entered in screens 7.1 through 7.6. Up to two additional user-specified categories [I199 and I200] may be provided, or user-supplied categories may replace any of the existing categories. For the industrial user-added category, screen 7.7 requests a category description, the employment, and the gallons per day per employee coefficients. Parameters other than employment are not accepted in this category.

If the price difference adjustment is to be used for the industrial sector, the marginal water price for the sector in both the base year and the year concurrent with the industrial water use coefficients must be entered in data screen 7.7. Prices are entered as dollars per 1,000 gallons in 1980 dollars.

Public/Unaccounted Data

Two different methods of calculating public/unaccounted water requirements are available. The first produces calculations based on water use parameters and requires the input of population data in screen 8.1. Note that the population entered on screen 8.1 is not necessarily the population residing in the study area, but rather the population served by the distribution system. If a value for population is provided, distribution losses (including leakage and apparent losses caused by cumulative meter misregistration) will be calculated on a per capita basis using default coefficients in the water use coefficient library and the supplied population. The default library coefficient is 15 gallons per capita per day. However, if a value of zero is entered or if no value for population is supplied in screen 8.1, IWR-MAIN calculates distribution losses as a percentage of the total municipal water use (the default value is 15 percent of production or 17.65 percent of water use). Free service (including water supplies to all nonrevenue-producing users) is always calculated as a per capita estimate using resident population from the general Municipal Base Year Data Screen (1.1) and from screen 9.1 for forecast years and the default value of five gallons per capita per day. The default coefficients can be changed by editing the library with a text editor. See section 4.4 for the structure of the library file.

The second method of public/unaccounted water use estimation by IWR-MAIN is through direct estimates supplied by the user for distribution losses, free service, and 14 additional user-specified parameters

[P001-P014]. Using screen 8.1, direct estimates for distribution losses and free service are entered as gallons per day for both average annual and maximum-day use. If desired, direct estimates of parameters as well as water use coefficients (in gallons per day per unit) may be entered in screen 8.2 for the user-specified public categories.

The provision of water use estimates for one category (distribution loss or free service) does not preclude the use of per capita or default calculations for the other category. However, if two methods are selected for the same category, the direct water use estimate will override the results of the default and per capita estimates.

TABLE II-5

PARAMETERS REQUIRED FOR ANALYSIS OF EACH RESIDENTIAL SUBGROUP

Residential Parameters	Subgroups			
	Metered-Sewered	Flat Rate-Sewered	Flat Rate-Unsewered	Master-Metered Apartments
Value ranges for dwelling units	X	X	X	X
Number of dwelling units in each value range	X	X	X	X
Housing density	X*	X	X	
Population density		X	X	X
Annual marginal price of water	X			
Summer marginal price of water	X			
Bill difference (annual)	X			
Bill difference (summer)	X			
Assessment factor (when assessed value used)	X	X	X	X

*Not required for metered and sewered areas west of 100th meridian.

TABLE II-6

LIST OF COMMERCIAL AND INSTITUTIONAL CATEGORIES AS CONTAINED IN THE IWR-MAIN SYSTEM

Category	Category Name	SIC Codes Included
C001	Miscellaneous commercial	All codes not listed below and not in the range 2000-3999
C002	Vocational school	8243,8244,8249,8291-99,8331-39,8611-99
C003	Miscellaneous retail	5201-5399,5601-99,5701-99,5901-99,7031-39,7833, 8231-39
C004	Boardinghouses	7021-29,7041-49
C005	Transportation terminal	4171,4581-89
C006	Barbers, cleaning	7212-17,7221-7249
C007	Power laundries	7211,7218
C008	Landscaping	0181-89,0781-0789,4971-79
C009	Miscellaneous wholesale	1501-1799,4172,4221-39,4959,5001-99,5111-39,5151-99,7261-69,7511-39,7549,7601-99,7811-19,8351-59, 8901-99
C010	Recreational facilities	7997
C011	Food and auto retail	5411-59,5463,5491-5599, 5813,7832,7931-39
C012	Dance studios	7911-19
C013	Hotels, restaurants	5812,7011-19,7992,7996,7999, 8411-19
C014	Electric, gas utilities	4911-39,4953,4961-69
C015	Public administration	9101-9799
C016	Schools, universities	8211-29
C017	Racetracks	7948
C018	Laboratories, water utilities	4941-49,4952,5141-49,7542, 8071-8079
C019	Health services	8081-99
C020	Medical offices, bakeries	5462,8011-49
C021	Nursing facilities	8051-59
C022	Hospitals	8061-69
C023	Zoological, etc., gardens	8421-29

TABLE II-7

COMMERCIAL AND INSTITUTIONAL CATEGORY
CROSS-REFERENCE WITH SIC CODES

SIC Code	Water Use Category	SIC Code	Water Use Category	SIC Code	Water Use Category
A. AGRICULTURE, FORESTRY, AND FISHING					
0111	n/a	0211	n/a	0741	n/a
0112	n/a	0212	n/a	0742	n/a
0115	n/a	0213	n/a	0751	n/a
0116	n/a	0214	n/a	0752	n/a
0119	n/a	0219	n/a	0761	n/a
0131	n/a	0241	n/a	0762	n/a
0132	n/a	0251	n/a	0781	08
0133	n/a	0252	n/a	0782	08
0134	n/a	0253	n/a	0783	08
0139	n/a	0254	n/a	0811	n/a
0161	n/a	0259	n/a	0821	n/a
0171	n/a	0271	n/a	0843	n/a
0172	n/a	0272	n/a	0849	n/a
0173	n/a	0279	n/a	0851	n/a
0174	n/a	0291	n/a	0912	n/a
0175	n/a	0711	n/a	0913	n/a
0179	n/a	0721	n/a	0919	n/a
0181	08	0722	n/a	0921	n/a
0182	08	0723	n/a	0971	n/a
0189	08	0724	n/a		
0191	n/a	0729	n/a		
B. MINING					
1011	n/a	1213	n/a	1454	n/a
1021	n/a	1311	n/a	1455	n/a
1031	n/a	1321	n/a	1459	n/a
1041	n/a	1381	n/a	1472	n/a
1044	n/a	1382	n/a	1473	n/a
1051	n/a	1389	n/a	1474	n/a
1061	n/a	1411	n/a	1475	n/a
1081	n/a	1422	n/a	1476	n/a
1092	n/a	1423	n/a	1477	n/a
1094	n/a	1429	n/a	1479	n/a
1099	n/a	1442	n/a	1481	n/a
1111	n/a	1446	n/a	1492	n/a
1112	n/a	1452	n/a	1496	n/a
1211	n/a	1453	n/a	1499	n/a
C. CONSTRUCTION					
1521	09	1711	09	1781	09
1522	09	1721	09	1791	09

TABLE II-7 (Continued)

SIC Code	Water Use Category	SIC Code	Water Use Category	SIC Code	Water Use Category
1531	09	1731	09	1793	09
1541	09	1741	09	1794	09
1549	09	1742	09	1795	09
1611	09	1743	09	1796	09
1622	09	1751	09	1799	09
1623	09	1752	09		
1629	09	1761	09		
D. MANUFACTURING					
[SIC Codes 2001-3999 included in Industrial Submodel]					
E. TRANSPORTATION AND PUBLIC UTILITIES					
4011	01	4422	01	4783	01
4013	01	4423	01	4784	01
4041	01	4431	01	4789	01
4111	01	4441	01	4811	01
4119	01	4452	01	4821	01
4121	01	4453	01	4832	01
4131	01	4454	01	4833	01
4141	01	4459	01	4899	01
4142	01	4463	01	4911	14
4151	01	4464	01	4922	14
4171	05	4469	01	4923	14
4172	09	4511	01	4924	14
4212	01	4521	01	4925	14
4213	01	4582	05	4931	14
4214	01	4583	05	4932	14
4221	09	4612	01	4939	14
4222	09	4613	01	4941	18
4224	09	4619	01	4952	18
4225	09	4712	01	4953	14
4226	09	4722	01	4959	09
4231	09	4723	01	4961	14
4311	01	4742	01	4971	08
4411	01	4743	01		
4421	01	4782	01		
F. WHOLESALE TRADE					
5012	09	5083	09	5144	18
5013	09	5084	09	5145	18
5014	09	5085	09	5146	18
5021	09	5086	09	5147	18
5023	09	5087	09	5148	18
5031	09	5088	09	5149	18

TABLE II-7 (Continued)

SIC Code	Water Use Category	SIC Code	Water Use Category	SIC Code	Water Use Category
5039	09	5093	09	5152	09
5041	09	5094	09	5153	09
5042	09	5099	09	5154	09
5043	09	5111	09	5159	09
5051	09	5112	09	5161	09
5052	09	5113	09	5171	09
5063	09	5122	09	5172	09
5064	09	5133	09	5181	09
5065	09	5134	09	5182	09
5072	09	5136	09	5191	09
5074	09	5137	09	5194	09
5075	09	5139	09	5198	09
5078	09	5141	18	5199	09
5081	09	5142	18		
5082	09	5143	18		
G. RETAIL TRADE					
5211	03	5561	11	5931	03
5231	03	5571	11	5941	03
5251	03	5599	11	5942	03
5261	03	5611	03	5943	03
5271	03	5621	03	5944	03
5311	03	5631	03	5945	03
5331	03	5641	03	5946	03
5399	03	5651	03	5947	03
5411	11	5661	03	5948	03
5422	11	5681	03	5949	03
5423	11	5699	03	5961	03
5431	11	5712	03	5962	03
5441	11	5713	03	5963	03
5451	11	5714	03	5982	03
5462	20	5719	03	5983	03
5463	11	5722	03	5984	03
5499	11	5732	03	5992	03
5511	11	5733	03	5993	03
5521	11	5812	13	5994	03
5531	11	5813	11	5999	03
5541	11	5912	03		
5551	11	5921	03		
H. FINANCE, INSURANCE, AND REAL ESTATE					
6011	01	6131	01	6512	01
6022	01	6142	01	6513	01
6023	01	6143	01	6514	01
6024	01	6144	01	6515	01
6025	01	6145	01	6517	01
6026	01	6146	01	6519	01
6027	01	6149	01	6531	01

TABLE II-7 (Continued)

SIC Code	Water Use Category	SIC Code	Water Use Category	SIC Code	Water Use Category
6028	01	6153	01	6541	01
6032	01	6159	01	6552	01
6033	01	6162	01	6553	01
6034	01	6163	01	6611	01
6042	01	6211	01	6711	01
6044	01	6221	01	6722	01
6052	01	6231	01	6723	01
6054	01	6281	01	6724	01
6055	01	6311	01	6725	01
6056	01	6321	01	6732	01
6059	01	6324	01	6733	01
6112	01	6331	01	6792	01
6113	01	6351	01	6793	01
6122	01	6361	01	6794	01
6123	01	6371	01	6799	01
6124	01	6399	01		
6125	01	6411	01		
I. SERVICES					
7011	13	7396	01	8021	20
7021	04	7397	01	8031	20
7032	03	7399	01	8041	20
7033	03	7512	09	8042	20
7041	04	7513	09	8049	20
7211	07	7519	09	8051	21
7212	06	7523	09	8059	21
7213	06	7525	09	8062	22
7214	06	7531	09	8063	22
7215	06	7534	09	8069	22
7216	06	7535	09	8071	18
7217	06	7538	09	8072	18
7218	07	7539	09	8081	19
7219	01	7542	18	8091	19
7221	06	7549	09	8111	01
7231	06	7622	09	8211	16
7241	06	7623	09	8221	16
7251	01	7629	09	8222	16
7261	09	7631	09	8231	03
7299	01	7641	09	8241	01
7311	01	7692	09	8243	02
7312	01	7694	09	8244	02
7313	01	7699	09	8249	02
7319	01	7813	09	8299	02
7321	01	7814	09	8321	01
7331	01	7819	09	8331	02
7332	01	7823	01	8351	09
7333	01	7824	01	8361	01
7339	01	7829	01	8399	01
7341	01	7832	11	8411	13

TABLE II-7 (Continued)

SIC Code	Water Use Category	SIC Code	Water Use Category	SIC Code	Water Use Category
7342	01	7833	03	8421	23
7349	01	7911	12	8611	02
7351	01	7922	01	8621	02
7361	01	7929	01	8631	02
7362	01	7932	11	8641	02
7369	01	7933	11	8651	02
7372	01	7941	01	8661	02
7374	01	7948	17	8699	02
7379	01	7992	13	8811	01
7391	01	7993	01	8911	01
7392	01	7996	13	8922	01
7393	01	7997	10	8931	01
7394	01	7999	13	8999	09
7395	01	8011	20		
J. PUBLIC ADMINISTRATION					
9111	15	9229	15	9532	15
9121	15	9311	15	9611	15
9131	15	9411	15	9621	15
9199	15	9431	15	9631	15
9211	15	9441	15	9641	15
9221	15	9451	15	9651	15
9222	15	9511	15	9661	15
9223	15	9512	15	9711	15
9224	15	9531	15	9721	15
K. NONCLASSIFIABLE ESTABLISHMENTS					
9999	n/a				

n/a = not assigned.

TABLE II-8

LIST OF INDUSTRIAL CATEGORIES AS CONTAINED IN THE IWR-MAIN SYSTEM

Data Name	SIC No.	Industrial Category
I001	201	Meat Products
I002	2011	Meat Packing Plants
I003	2013	Sausages & Other Prepared Meats
I004	2016	Poultry Dressing Plants
I005	2017	Poultry & Egg Processing
I006	202	Dairy Products
I007	203	Preserved Fruits & Vegetables
I008	204	Grain Mill Products
I009	205	Bakery products
I010	2051	Bread, Cake & Related Products
I011	2052	Cookies & Crackers
I012	206	Sugar & Confectionery Products
I013	207	Fats & Oils
I014	208	Beverages
I015	2082	Malt Beverages
I016	2086	Bottled & Canned Soft Drinks
I017	2087	Flavoring Extracts & Syrups, nec
I018	209	Misc. Foods & Kindred Products
I019	211	Cigarettes
I020	212	Cigars
I021	213	Chewing & Smoking Tobacco
I022	214	Tobacco Stemming & Redrying
I023	221	Weaving Mills, Cotton
I024	222	Weaving Mills, Synthetics
I025	223	Weaving & Finishing Mills, Wool
I026	224	Narrow Fabric Mills
I027	225	Knitting Mills
I028	226	Textile Finishing, exc. Wool
I029	227	Floor Covering Mills
I030	228	Yarn & Thread Mills
I031	229	Misc. Textile Goods
I032	230	Apparel & Other Textile Products
I033	241	Logging Camps & Logging Contractors
I034	242	Sawmills & Planing Mills
I035	243	Millwork, Plywood & Struct. Members
I036	244	Wood Containers
I037	245	Wood Buildings & Mobile Homes
I038	249	Misc. Wood Products
I039	251	Household Furniture
I040	252	Office Furniture
I041	253	Public Building & Related Furniture
I042	254	Partitions & Fixtures
I043	259	Misc. Furniture & Fixtures
I044	261	Pulp Mills
I045	262	Paper Mills, exc. Building Paper
I046	263	Paperboard Mills
I047	264	Misc. Converted Paper Products

TABLE II-8 (Continued)

Data Name	SIC No.	Industrial Category
I048	265	Paperboard Containers & Boxes
I049	266	Building Paper & Board Mills
I050	270	Printing & Publishing
I051	281	Industrial Inorganic Chemicals
I052	282	Plastics Materials & Synthetics
I053	283	Drugs
I054	2831	Biological Products
I055	2833	Medicinals & Botanicals
I056	2834	Pharmaceutical Preparations
I057	284	Soap, Cleaners & Toilet Goods
I058	285	Paints & Allied Products
I059	286	Industrial Organic Chemicals
I060	2861	Gum & Wood Chemicals
I061	2865	Cyclic Crudes & Intermediates
I062	2869	Industrial Organic Chemicals, nec
I063	287	Agricultural Chemicals
I064	289	Misc. Chemical Products
I065	291	Petroleum Refining
I066	295	Paving & Roofing Materials
I067	299	Misc. Petroleum & Coal Products
I068	301	Tires & Inner Tubes
I069	302	Rubber & Plastics Footwear
I070	303	Reclaimed Rubber
I071	304	Rubber & Plastics Hose & Belting
I072	306	Fabricated Rubber Products, nec
I073	307	Misc. Plastics Products
I074	311	Leather Tanning & Finishing
I075	313	Boot & Shoe Cut Stock & Findings
I076	314	Footwear exc. Rubber
I077	315	Leather Gloves & Mittens
I078	316	Luggage
I079	317	Handbags & Personal Leather Goods
I080	319	Leather Goods, nec
I081	321	Flat Glass
I082	322	Glass & Glassware, Pressed or Blown
I083	323	Products of Purchased Glass
I084	324	Cement, Hydraulic
I085	325	Structural Clay Products
I086	326	Pottery & Related Products
I087	327	Concrete, Gypsum & Plaster Products
I088	328	Cut Stone & Stone Products
I089	329	Misc. Nonmetallic Mineral Products
I090	331	Blast Furnace & Basic Steel Products
I091	3312	Blast Furnaces & Steel Mills
I092	3313	Electrometallurgical Products
I093	3315	Steel Wire & Related Products
I094	3316	Cold Finishing of Steel Shapes
I095	3317	Steel Pipe & Tubes
I096	332	Iron & Steel Foundries

TABLE II-8 (Continued)

Data Name	SIC No.	Industrial Category
I097	3321	Gray Iron Foundries
I098	3322	Malleable Iron Foundries
I099	3324	Steel Investment Foundries
I100	3325	Steel Foundries, nec
I101	333	Primary Nonferrous Metals
I102	334	Secondary Nonferrous Metals
I103	335	Nonferrous Rolling & Drawing
I104	336	Nonferrous Foundries
I105	339	Misc. Primary Metal Products
I106	341	Metal Cans & Shipping Containers
I107	342	Cutlery, Hand Tools & Hardware
I108	343	Plumbing & Heating, exc. Electric
I109	344	Fabricated Structural Steel Products
I110	3441	Fabricated Structural Metal
I111	3442	Metal Doors, Sash & Trim
I112	3443	Fabricated Plate Work (Boiler Shops)
I113	3444	Sheet Metal Work
I114	3446	Architectural Metal Work
I115	3448	Prefabricated Metal Buildings
I116	3449	Misc. Metal Work
I117	345	Screw Machine Products, Bolts, etc.
I118	346	Metal Forgings & Stampings
I119	3462	Iron & Steel Forgings
I120	3463	Nonferrous Forgins
I121	3465	Automotive Stampings
I122	3466	Crowns & Closures
I123	3469	Metal Stampings, nec
I124	347	Metal Services, nec
I125	348	Ordnance & Accessories, nec
I126	349	Misc. Fabricated Metal Products
I127	351	Engines & Turbines
I128	352	Farm & Garden Machinery
I129	353	Construction & Related Machinery
I130	3531	Construction Machinery
I131	3532	Mining Machinery
I132	3533	Oil Field Machinery
I133	3534	Elevators & Moving Stairways
I134	3535	Conveyors & Conveying Equipment
I135	3536	Hoists, Cranes & Monorails
I136	3537	Industrial Trucks & Tractors
I137	354	Metalworking Machinery
I138	355	Special Industry Machinery
I139	356	General Industrial Machinery
I140	357	Office & Computing Machines
I141	3572	Typewriters
I142	3573	Electronic Computing Equipment
I143	3574	Calculating & Accounting Machines
I144	3576	Scales & Balances, exc. Laboratory
I145	3579	Office Machines, nec
I146	358	Refrigeration & Service Machinery

TABLE II-8 (Continued)

Data Name	SIC No.	Industrial Category
I147	3581	Automatic Merchandising Machines
I148	3582	Commercial Laundry Equipment
I149	3585	Refrigeration & Heating Equipment
I150	3586	Measuring & Dispensing Pumps
I151	3589	Service Industry Machinery, nec
I152	359	Misc. Machinery, exc. Electrical
I153	3592	Carburetors, Pistons, Rings, Valves
I154	3599	Machinery, exc. Electrical, nec
I155	361	Electric Distributing Equipment
I156	362	Electrical Industrial Apparatus
I157	363	Household Appliances
I158	364	Electric Lighting & Wiring Equipment
I159	365	Radio & TV Receiving Equipment
I160	366	Communication Equipment
I161	367	Electronic Components & Accessories
I162	3671	Electron Tubes, Receiving Type
I163	3672	Cathode Ray Television Picture Tubes
I164	3673	Electron Tubes, Transmitting
I165	3674	Semiconductors & Related Devices
I166	3675	Electronic Capacitors
I167	3676	Electronic Resistors
I168	3677	Electronic Coils & Transformers
I169	3678	Electronic Connectors
I170	3679	Electronic Components, nec
I171	369	Misc. Electrical Equipment & Supplies
I172	371	Motor Vehicles & Equipment
I173	3711	Motor Vehicles & Car Bodies
I174	3713	Truck & Bus Bodies
I175	3714	Motor Vehicle Parts & Accessories
I176	3715	Truck Trailers
I177	372	Aircraft & Parts
I178	3721	Aircraft
I179	3724	Aircraft Engines & Engine Parts
I180	3728	Aircraft Equipment, nec
I181	373	Ship & Boat Building & Repairing
I182	374	Railroad Equipment
I183	375	Motorcycles, Bicycles & Parts
I184	376	Guided Missiles, Space Vehicles, Parts
I185	379	Misc. Transportation Equipment
I186	381	Engineering & Scientific Instruments
I187	382	Measuring & Controlling Devices
I188	383	Optical Instruments & Lenses
I189	384	Medical Instruments & Supplies
I190	385	Opthalmic Goods
I191	386	Photographic Equipment & Supplies
I192	387	Watches, Clocks & Watchcases
I193	391	Jewelry, Silverware & Plated Ware
I194	393	Musical Instruments
I195	394	Toys & Sporting Games

TABLE II-8 (Continued)

Data Name	SIC No.	Industrial Category
I196	395	Pens, Pencils, Office & Art Supplies
I197	396	Costume Jewelry & Notions
I198	399	Misc. Manufactures

nec = not elsewhere classified.

3.2 PROJECTION DATA

Projection Methods

IWR-MAIN allows for three different methods of projecting water use parameters. Any combination of these methods may be used for any specified forecast year. Each forecast year is treated independently, thus the specification of one method for the first forecast year does not mean that the same method or combination of methods must be used for a subsequent forecast year. The three methods of projection, specified on the Parameter Control Screen, include:

(1) Projection by internal growth models
(2) Projection by extrapolation of local historical data
(3) Use of projections made external to the IWR-MAIN System

Key Projection Data

IWR-MAIN requires certain key projection data regardless of the projection methods used. The data values entered on data screens 9.1 through 9.4 include:

(1) Year -- calendar year of water use forecast (not more than 50 years after the base year).
(2) Population -- total resident population in the study area in forecast year.
(3) Median household income -- projected median household income in forecast year, expressed in 1980 dollars.
(4) Total employment -- total study area employment in forecast year.
(5) Total number of households -- total number of housing units in forecast year (optional).
(6) Fraction of households with forecast year income: (<$10,000); ($10,000-$20,000); ($20,000-$30,000) -- fraction of households with forecast year income in respective ranges. Income ranges are expressed in 1980 dollars (optional).
(7) Employment by sector -- construction (SIC 1500-1799); manufacturing (SIC 2000-3999); transportation, communication, and utilities (SIC 4000-4999); wholesale trade (SIC 5000-5199); retail trade (SIC 5200-5999); finance and banking (SIC 6000-6799); services (SIC 7000-8999); and government (SIC 9100-9799) employment for forecast year (optional).

Included on the IWR-MAIN Utility Diskette (Diskette #5) is an External Projection Module which provides key socioeconomic projections for selected areas in the United States (see Appendix C). These projections may be used as a data source for the key projection data.

Historical Data

Certain water use parameters may be projected by extrapolating local historical data. These projections will override projections generated by the internal growth models. Extrapolation of local historical data will occur whenever at least two, but not more than seven, data points are provided for the parameter in one of the subgroups described below.

Projection by extrapolation of historical trends may be selected for residential parameters by entering the necessary data using screens 10.1 and 10.2. The residential parameters consist of the number of housing units within all value ranges whose midpoints (midrange values expressed in 1980 dollars) fall into one of the following groups:

		Price Range and Other
Group 1 (low)	--	units with market value < $25,000
Group 2	--	units with market value $25,000-$50,000

Group 3	--	units with market value $50,000-$100,000
Group 4 (high)	--	units with market value > $100,000
Total	--	total housing units

Commercial/institutional and industrial category parameters may also be projected by extrapolation of local historical trends using data screens 11.1 to 11.4 (commercial/institutional) and 12.1 to 12.a (industrial). These screens directly correspond to the Base Year screens 6.1 and 6.2 (commercial/institutional) and screens 7.1 through 7.7 (industrial). If values were input into these Base Year screens, those categories ([C0xx] and SIC categories) will be highlighted in the Historical Parameter screens. Data must be entered for at least two years, but not more than seven years, and may include the base year.

Public/unaccounted historical parameters are entered on screens 13.1 and 13.2. These parameters may be projected by extrapolation of historical data for two to seven years. Parameters include population (number of persons) for distribution loss [LOSS] and per capita water use for free service [FSER]. If any user-specified parameters [P001-P014] were included in Base Year screen 8.2, these parameter variables will be highlighted in the Historical Parameter screens. The parameter units for each category [P0xx] should be the same as those specified in the Base Year screen (i.e., if [P001] was specified as restrooms in the Base Year screen, parameter units to be extrapolated in the Historical Parameter screens should be restrooms for [P001]).

External Data

Water use parameters may also be projected by direct external input, replacing any historical extrapolations or internal projections. These external estimates are projections from outside sources and will supersede the results of the historical extrapolations and parameters generated by the internal growth models.

External projections are entered in data screens 14.x.1 through 14.x.9 where x is a designated forecast year. Each municipal sector (residential, commercial, industrial, and public/unaccounted) is represented on a separate screen(s). Not all municipal sectors or forecast years need be addressed.

Residential

The possible combinations for the residential subgroup parameter labels are:

		Residential Subgroup
[FW]	--	flat rate and sewered
[FP]	--	flat rate and unsewered
[MW]	--	metered and sewered
[AP]	--	master-metered apartment

		Price Range and Other
[G1]	--	units with midrange market value < $25,000
[G2]	--	units with midrange market value $25,000-$50,000
[G3]	--	units with midrange market value $50,000-$100,000
[G4]	--	units with midrange market value > $100,000
[TL]	--	total housing units

Parameter units are housing units. The parameter labels consist of one residential subgroup and one price range (or total). For example, MWG1, MWTL, FPG4, APTL.

Commercial/Institutional

In the case of the commercial/institutional subgroup, the parameter labels are the [C0xx] categories and the parameter units are employment for [C001-C023]. For categories [C024-C050] parameter units may be employment or any other user-specified unit as previously specified in data screens 6.2 and 6.3.

Industrial

Industrial parameter labels are the [I001-I198] categories which directly correspond to SIC codes appearing in data screens 7.1 through 7.6; see Table II-8 for a cross-reference between SIC codes and [Ixxx] categories. The user may also provide projection data for the two additional industrial categories [I199 and I200] provided that the categories were specified in screen 7.7.

Public/Unaccounted

Public/unaccounted parameters are entered as direct external projections in units as specified in screens 8.1 and 8.2, or water use (average annual and maximum-day) may be entered. If distribution losses are specified for future years, they may be entered as a percent of total municipal, the population base (parameter) from which to calculate per capita loss, or the water loss in gallons per day. Free service data may be entered as the population base or the water use in gallons per day. Parameter categories include:

[FLSS] -- percent distribution loss (percent of total municipal water use)
[LOSS] -- distribution losses (population or gallons per day)
[FSER] -- free service (population or gallons per day)
[P001-P027] -- user-specified categories (units or gallons per day)

3.3 CONSERVATION DATA

The conservation routine will generate estimates of restricted water use if the conservation option is selected on the Parameter Control Screen. The restricted water use incorporates the reduction of water use achieved by the selected conservation measures. The effectiveness, or the magnitude of this reduction, is calculated as the product of unrestricted water use times the reduction and coverage parameters. Data screen 15.1 enables the user to select up to 14 specified conservation measures, defined within the model, and four additional user-specified measures. These measures are selected by entering the year of implementation next to the corresponding measure. The implementation year may be a past or a current year (existing measure) or a future year (future measure). The sectors to which the selected measures apply are specified on screen 15.2.

The 14 specified measures have default values for reduction factors and for the calculation of coverage residing in the Library of Conservation Coefficients (LCC). IWR-MAIN allows the user the option of specifying all or some of the reduction and coverage factors while letting the LCC provide the others. On the other hand the user may specify that the LCC provide all of the reduction factors and calculate all of the coverage factors. However, if user-specified measures are selected, all reduction and coverage factors for these measures must be specified by the user because a value of zero is assigned to them in the LCC.

Reduction factors are specified for each measure and sector for indoor use (data screen 16.2), outdoor use (data screen 16.3), and maximum-day sprinkling use (data screen 16.4). Reduction factors represent a fraction reduction of water use and must be between 0.000 and 1.000.

Coverage factors may also be specified for each measure and sector for the base year (data screen 17.2) and for each selected forecast year (data screens 17.3 to 17.x). Entry of these coverage factors is similar to that of the reduction factors in that only values between 0.000 and 1.000 are allowed.

3.4 POSSIBLE DATA SOURCES

As stated previously, two kinds of data are required to use the IWR-MAIN System: (1) actual values of all demographic and socioeconomic determinants (or parameters) of water use for the base year and (2) projected values of selected determinants for each forecast year. If the conservation procedure is selected, a minimum amount of information is required about the implementation of conservation measures. If verification of the IWR-MAIN base year water use estimates is desired, actual water use records (preferably disaggregated by customer class) should be obtained.

The level of difficulty of the data collection effort depends, to a large extent, on the level of user sector disaggregation and the study area definition. Water use can be separately forecast by IWR-MAIN for each of four major sectors (residential, commercial/institutional, industrial, and unaccounted) and for up to approximately 380 individual categories. For example, at the maximum level of residential disaggregation, four residential subgroups may be addressed: flat rate and sewered, flat rate and unsewered, metered and sewered, and master-metered apartments. Within each subgroup, 25 home value ranges may be specified. Data collection at this level of detail may require a significant amount of time and effort. Alternatively, at a low level of disaggregation, residential data could be aggregated into the metered and sewered and apartment subgroups (assuming a single-family and multifamily distinction) and address only 10 value ranges in each. Similar aggregations can be applied to the commercial/institutional and industrial sectors. However, it should be noted that the more aggregated the model, the fewer the data requirements, the greater the need for calibration against local water use, and the lower the confidence which can be placed in the resulting forecast.

The study area definition also determines the level of data collection efforts. This is because the most detailed, disaggregate socioeconomic data are available for major urban cities, counties, and standard metropolitan statistical areas. The smaller the study area in size and population, the less the availability of disaggregate socioeconomic data and the more reliance which must be placed on data from local agencies. In cases where socioeconomic data are available for a large area (county) but not available for small areas (city), the large area data can be disaggregated by a shift-share method. In its simplest form, this method is based on a historical record of small-area shares of the large-area aggregate.

There are three major sources of data available to IWR-MAIN users. First, data may be obtained from published reports, most notably from the U.S. Bureau of the Census or the Bureau of Labor Statistics. These publications can be found in most research libraries. Second, data may be obtained from local, regional, or state agencies, including water resource boards, employment security divisions, departments of community and economic affairs, and planning agencies. Listings of state and regional agencies may be found in most public libraries. Third, independent firms specializing in economic or market-oriented data may also be utilized. Common data sources for selected variables are shown in Table II-9.

TABLE II-9

DATA TYPES AND POSSIBLE SOURCES

Data Category	Specific Data Items	Possible Data Sources
1. Population	a. Population; household size b. Population projections	U.S. Census of Population, housing; local and state planning agencies; city and county data books; state demographer; local and state economic development agencies; econometric firms; state and national statistical abstracts; OBERS regional projections
2. Housing	a. Number of housing units by type and by market value; housing density; average lot sizes; assessed valuations b. Housing unit projections by type	U.S. Census of Population, housing; U.S. Census Metropolitan Housing Characteristics; local and state planning agencies; real estate asssessment agencies; state demographer; state financial agencies; local and state economic development agencies; local zoning commission; econometric firms; OBERS regional projections
3. Employment	a. Total employment by major industry sectors: employment disaggregated by 3- and 4-digit SIC categories; local historical employment growth rates b. Aggregate and disaggregate (by SIC) employment projections	U.S. Census of Population: Detailed Socioeconomic Characteristics; U.S. Census: County Business Patterns; U.S. Census of Manufacturers, Services, Wholesale Trade, etc.; local and state planning agencies; U.S. Bureau of Labor Statistics; U.S. Department of Commerce: Monthly Labor Review; employment security divisions; local and state economic development agencies; state financial agencies; econometric firms; local manufacturing directory; local services directory; Chambers of Commerce employment listings; OBERS regional projections
4. Other economic variables	a. Consumer Price Index; construction cost index; personal and household income b. Income projections	U.S. Census of Population: Detailed Socioeconomic Characteristics; local and state planning agencies; state financial agencies; Department of Commerce: Monthly Labor Review; state and national statistical abstracts; U.S. Bureau of Labor Statistics; econometric firms; OBERS regional projections
5. Climate	Local weather patterns: rainfall, temperature, evapotranspiration rates, moisture deficit (normal and temporal conditions)	National Oceanic and Atmospheric Administration (NOAA); National Weather Service; university experiment stations; soil and water conservation districts; local airports
6. Land use	Land use patterns; zoning ordinances	U.S. Census of Agriculture; local and state planning agencies; city zoning commissions; city directories; U.S. Census: Block Statistics Reports

TABLE II-9 (Continued)

Data Category	Specific Data Items	Possible Data Sources
7. Water statistics	Water/wastewater prices and rate structures; historical monthly water use by customer class; historical monthly number of accounts by customer class; historical data on unaccounted losses; scope of self-supplied users	Local water supply agency; engineering reports; state water surveys; customer surveys; state regulatory agency; local government ordinances
8. Conservation	Implemented conservation measures; future conservation alternatives; measurements of reduction, coverage, or effectiveness of measures; social acceptability; institutional framework; water-using appliances	Local water supply agencies; state regulatory agency; local ordinances and regulatory statistics; local and state planning agencies; interviews of government officials and general public; consumer (satisfaction evaluation) reports; manufacturer (water-using appliance) specifications; literature studies

4. COMPUTATIONAL METHODS

This chapter presents the computational methods used by IWR-MAIN to estimate unrestricted and restricted water use and to forecast water use parameters. The data bases used to derive the water use equations and coefficients are presented and discussed. To facilitate verification of water use coefficients under local conditions, this chapter concludes with a discussion of the correspondence between the water use models and the data contained in the IWR-MAIN coefficient libraries.

4.1 WATER USE EQUATIONS

As mentioned briefly in chapter 2, the computational procedures of IWR-MAIN are a mixture of water use estimating techniques (refer to Table II-1). This section presents the water use estimating methods for each of the major urban water use sectors.

Residential Use Models

Most of the residential water use models contained in IWR-MAIN are based on data collected from the Residential Water Use Research Project by the Johns Hopkins University. Under sponsorship by the Technical Studies Program of the Federal Housing Administration and in cooperation with 16 participating utilities, the Johns Hopkins University conducted studies between 1961 and 1966 to (1) determine the water use patterns and demand rates imposed on water systems in residential areas and (2) determine the major factors influencing residential water use. Master-meter, punched tape recorder systems were installed to continuously monitor water flow into 39 homogeneous residential areas. The 39 study areas were served by 16 water utilities and ranged in size from 34 dwelling units to 2,373 dwelling units. The resulting data from this study consisted of observations on average values (per dwelling unit) of the relevant water use explanatory variables for 39 study areas (Linaweaver et al., 1966; Howe and Linaweaver, 1967).

Using the data generated by the Residential Water Use Research Project, Howe and Linaweaver (1967) provided a comprehensive econometric analysis, yielding water use models for five categories of residential water use:

(1) Metered and sewered residences in the western United States
(2) Metered and sewered residences in the eastern United States
(3) Metered residences with septic tanks
(4) Flat rate and sewered residences
(5) Apartment areas

Some of the explanatory variables used in the demand analysis included:

(1) Market value of residence
(2) Number of persons per dwelling unit
(3) Age of dwelling unit
(4) Average water pressure
(5) Marginal water and sewer charge
(6) Irrigable area per dwelling unit
(7) Summer potential evapotranspiration in inches

For each housing category, regression equations were estimated for domestic demand, summer sprinkling demand, and maximum-day demand.

In 1982, Howe reestimated some of the Howe and Linaweaver (1967) equations, incorporating an explanatory variable that had not been considered previously: the bill difference variable. The bill difference is calculated as the difference between the total water/wastewater bill and the product of marginal water/wastewater price and water use. It is expressed in dollars per billing period and reflects the additional impact on disposable income, beyond that of the marginal price, imposed by the particular rate structure in use. Howe only attempted reestimation of the metered and sewered equations, and the resulting significant equations replaced those in IWR-MAIN from Howe and Linaweaver (1967). Howe's updated results indicated a substantially improved fit of the models to the data.

Currently, the IWR-MAIN System contains four residential water use categories: (1) flat rate and sewered residences, (2) flat rate and unsewered residences, (3) metered and sewered residences, and (4) master-metered apartments. IWR-MAIN water use estimates for the residential sector are presented in 1,000 gallons per day for the dimensions of winter, summer, average annual, and maximum-day water use. The water demand functions for each residential category are presented in the following sections.

Metered and Sewered Models

The metered and sewered housing category includes single-family residential units that are individually metered and are served by a public sewer system. The housing units are considered owner-occupied or occupied by renters who are responsible for paying the water and wastewater bill. The residential demand models for metered and sewered water use are presented in Table II-10. Based on Howe and Linaweaver (1967) and Howe (1982), these models were later revised to include new coefficient values to permit housing value and price data to be provided in 1980, rather than 1960, dollars.

The price elasticity of water demand in the winter usage equation is -0.20 when the effects of change in the water rate structure on disposable income that are captured by the bill difference are ignored and -0.06 when such effects are taken into account. The elasticity of home value (a proxy for income) is 0.32.

The price elasticities of summer demand are -0.52 for the west (without the effects of bill difference) and -0.57 for the east (including the effects of bill difference). Corresponding home value elasticities are 0.43 and 0.34.

Note that the summer eastern equation includes the moisture deficit (MD) variable. The summer western equation is the sum of a summer sprinkling term and the domestic water use. The summer sprinkling term of the western equation includes a weather adjustment factor (WF) which permits the calibration of the model to actual weather conditions of a specific year. The weather adjustment factor has a default value of 1.0. The calibration procedure is described in Part II, section 5.3.

Flat Rate Models

The flat rate categories include housing units that are occupied by customers who face a zero marginal price. The distinction between the flat rate and sewered and the flat rate and unsewered is the use of a public sewer system. Flat rate units may be single-family customers who pay a flat charge for their water and wastewater services. Alternatively, flat rate units may also include low-density multifamily customers (duplex, mobile homes) who are not individually metered or renter-occupied households where the owner pays the water and wastewater bill.

The residential water use models for flat rate and sewered water use are presented in Table II-11. The winter water use model is based on the Johns Hopkins University sample of flat rate and apartment customers and exhibits a housing value elasticity of 0.33. The summer water use model is based on the sample of flat rate, single-family customers. The corresponding housing value elasticity for summer demand is 0.70.

The residential water use models for flat rate and unsewered water use are presented in Table II-12. The winter water use model is based on the Johns Hopkins University sample of customers with septic tanks.

However, no significant summer sprinkling water use equations were derived by Howe and Linaweaver (1967) for septic tank users. Therefore, the summer sprinkling model for flat rate and unsewered customers is the same as that for flat rate and sewered customers. The housing value elasticity for summer water demand is 0.64.

Apartment Models

The master-metered apartment category refers to housing units which face a zero marginal price and have little opportunity to engage in outdoor (seasonal) water uses. It is assumed that these units are provided with sewer services.

The residential water use models for master-metered apartment water use are presented in Table II-13. The winter water use model is based on the Johns Hopkins University sample of flat rate and apartment customers and exhibits a housing value elasticity of 0.33. Summer and maximum-day apartment water use are set equal to 1.433 times winter day use. This factor was derived from the observed summer and winter water use in the five apartment areas included in the Johns Hopkins University study.

Commercial/Institutional Coefficients

The calculation of commercial and institutional water use is based on the single coefficient requirement, or unit use, method. Commercial/institutional water use is estimated on a per employee basis using the following formulas:

$$(Q_a)_c = (C_a)_c * P_c * ADJ$$

and

$$(Q_{mxdy})_c = (C_{mxdy})_c * P_c * ADJ$$

where

Q = water usage for a particular category, gallons per day
C = commercial/institutional water use coefficient, gallons per employee per day
P = water use parameter, employment
ADJ = price difference adjustment; ADJ = $(PRb/PRc)^e$
PRb = marginal price paid by average customer during the base year
PRc = marginal price paid by average customer during the year for which coefficient c was established
e = price elasticity for sector

and subscripts indicate the following water use types:

a = average annual use
c = commercial/institutional use category
mxdy = maximum-day use

Table II-14 presents the 23 commercial/institutional water use categories specified by the IWR-MAIN System. The 23 categories are the result of identifying and aggregating four-digit SIC categories by similar water use activities. The water use coefficients for each category were derived from a 1984 survey of 2,261 establishments served by 41 water utilities (Boland et al., 1985). For each surveyed establishment, annual water use and employment were obtained.

The price difference adjustment is calculated using the ratio of marginal prices in the base year and the year concurrent with the water use coefficients. These prices are provided by the user in the input data. The elasticity of commercial water use with respect to price is read from the library of water use coefficients (see

Part II, section 4.4). The default value of -0.80 was selected from a range of commercial price elasticities reported by Boland et al. (1984). See the discussion of price elasticities in the description of reduction factors for the price policy conservation measure in Part II, section 4.3. The user may wish to estimate the price elasticity for the commercial sector of a given study area and replace the default value in the library. No price adjustment is made for user-added categories given that the user must compute and input the coefficients for these categories.

Industrial Coefficients

Industrial water use is also calculated based on the single coefficient requirement (per employee) method. Industrial water use is estimated using the following formulas:

$$(Q_a)_n = (C_a)_n * P_n * ADJ$$

and

$$(Q_{mxdy})_n = (C_{mxdy})_n * P_n * ADJ$$

where

- Q = water usage for a particular category, gallons per day
- C = industrial water use coefficient, gallons per employee per day
- P = water use parameter, employment
- ADJ = price difference adjustment; ADJ = $(PRb/PRc)^e$
- PRb = marginal price paid by average customer during the base year
- PRc = marginal price paid by average customer during the year for which coefficient c was established
- e = price elasticity for sector

and subscripts indicate the following water use types:

- a = average annual use
- n = industrial use category
- mxdy = maximum-day use

The water use rates per employee were derived from the U.S. Bureau of the Census report entitled "Water Use in Manufacturing" (U.S. Bureau of the Census, 1986). The census data were obtained from several sources including a special survey of 10,262 establishments reporting a total water intake of 20 million gallons or more in the 1982 Census of Manufacturers. The Industry Division of the Bureau of the Census performed a special employment tabulation for the original survey respondents to permit the calculation of per employee use rates at the three- and four-digit SIC categories. Table II-15 presents 198 employee use coefficients obtained by dividing total annual intake of water from public sources by the reported number of employees and the number of days in a year (365) for each SIC category.

Two sets of coefficients were developed. The first set represents use rates reported by the panel of 10,262 establishments which account for 96 percent of total water use estimated for manufacturers. The coefficients in this set represent establishments which use large quantities of water. The second set represents "average" establishments. The employee use coefficients in this set were calculated by making adjustments for the percent of total water intake and the percent of total employment accounted for by establishments included in the first set. For example, for category I055 representing four-digit SIC code 2833 (cellulosic manmade fibers) the coefficient in the first set is 1,200.0 gallons per employee per day. The coefficient for the "average" establishments in this industry was calculated according to the formula:

$$C_a = C_1 * (f_E/f_Q) = 1,200.0 * (0.627/0.992) = 758.5 \text{ ged}$$

where

C_a = water use coefficient for average establishment in the category in gallons per employee per day (ged)
C_l = water use coefficient for large water-using establishments in the category in gallons per employee per day (ged)
f_E = fraction of total employment in SIC category 28 accounted for by establishments using large quantities of water
f_Q = fraction of total water intake in SIC category 28 accounted for by establishments using large quantities of water

The second set of coefficients, representing "average" establishments, are contained in the IWR-MAIN coefficient library.

As in the adjustment of commercial water use, the price difference adjustment for industrial water use utilizes the ratio of marginal industrial water price in the base year to the marginal industrial water price in the year concurrent with the industrial water use coefficients. The default industrial price elasticity of -0.65 was selected from a range of aggregate elasticities for the industrial sector reported by Boland et al. (1984). The range is shown in the discussion of price elasticities for the reduction factor for the price policy conservation measure in Part II, section 4.3. As with the commercial price elasticity, the user may wish to estimate the price elasticity for the industrial sector of a given study area and replace the default value in the library. No price adjustment is made for user-added categories.

Public/Unaccounted Coefficients

Public water use is calculated based on a single coefficient requirement method using the following formulas:

$$(Q_a)_{pu} = (C_a)_{pu} * P_{pu}$$

and

$$(Q_{mxdy})_{pu} = (C_{mxdy})_{pu} * P_{pu}$$

where

Q = water usage for a particular category, gallons per day
C = public/unaccounted water use coefficient, gallons per day per unit
P = water use parameter, units

and subscripts indicate the following water use types:

a = average annual use
pu = public/unaccounted use category
mxdy = maximum-day use

IWR-MAIN has two built-in public/unaccounted water use categories: free service and distribution losses. Free service is calculated on a per capita basis using resident population as the parameter if average daily free service in gallons per day is not provided. Distribution losses are also calculated on a per capita basis provided that the population served by the distribution system is given. Alternatively, if the population served is not provided and if the daily losses in gallons per day are not provided, distribution losses are calculated on a percentage basis using total municipal water use as the parameter. Table II-16 presents the public/unaccounted water use categories and the corresponding water use coefficients. Water use for user-added public/unaccounted categories is calculated based on parameters and coefficients provided by the user.

TABLE II-10

METERED AND SEWERED RESIDENTIAL MODELS

1. Winter usage

$$(Q_D)_{ms} = (234 + 1.451\ V/Fa - 45.9\ P_a - 2.59\ I_a)N_r$$

2. Summer usage

$$(Q_s)_{ms,w} = (0.48 * 58.777 * P_s^{-0.703} * (V/Fa)^{0.429})N_r * 2.0 * WF + (Q_D)_{ms}$$

$$(Q_s)_{ms,e} = (385.0 + 2.876\ V/Fa - 285.8\ P_s - 4.35\ I_s + 157.77 * B * MD)N_r$$

where

$$B = 0.803 * H_d^{-1.26}$$
$$WF = (MD_{actual}/MD)^{md}$$

3. Average annual usage

$$(Q_a)_{ms,w} = [(Q_D)_{ms} + (Q_s)_{ms,w}]/2.0$$

$$(Q_a)_{ms,e} = [(Q_D)_{ms} + (Q_s)_{ms,e}]/2.0$$

4. Maximum-day sprinkling usage

$$(Q_{mxs})_{ms,w} = (2{,}227.34 * E_m^{2.06} * (V/Fa)^{0.413})\ N_r$$

$$(Q_{mxs})_{ms,e} = (0.000046 * B^{0.118} * E_m^{-10.4} * P_s^{1.25} * (V/Fa)^{0.931})\ N_r$$

5. Maximum-day usage

$$(Q_{mxdy})_{ms,w} = (Q_D)_{ms,w} + (Q_{mxs})_{ms,w}$$

$$(Q_{mxdy})_{ms,e} = (Q_D)_{ms,e} + (Q_{mxs})_{ms,e}$$

Definition of symbols

Q = water usage for a particular category, gallons per day
V = average home value in a range of value $1,000

$$V = \frac{V_{min} + V_{max}}{2 * 1{,}000}$$

Fa = assessment factor
P_a = effective annual marginal price of water, dollars per 1,000 gallons
I_a = effective annual bill difference variable, dollars per billing period
P_s = effective summer marginal price of water, dollars per 1,000 gallons
I_s = effective summer bill difference variable, dollars per billing period

TABLE II-10 (Continued)

B = irrigable land per dwelling unit, acres per unit
MD = summer season moisture deficit in inches

$$MD = E - 0.6R$$

E = summer season potential evapotranspiration, inches
R = summer season precipitation, inches
H_d = housing density, units per acre
E_m = maximum-day evapotranspiration, inches = 0.25 for west and 0.29 for east
N_r = number of residences in value range r
WF = weather adjustment factor

Subscripts and superscripts of water use types

ms = metered and sewered residential use
D = winter, or domestic, water use
s = summer season use
w = west of 100th meridian
e = east of 100th meridian
a = average annual use
mxs = maximum-day sprinkling use
mxdy = maximum-day use
actual = actual weather data value for specific calibration year
md = elasticity of water use with respect to moisture deficit

TABLE II-11

FLAT RATE AND SEWERED RESIDENTIAL MODELS

1. Winter usage

$$(Q_D)_{fs} = (28.9 + 1.576\ V/Fa + 33.6\ D_p)N_r$$

2. Summer usage

$$(Q_s)_{fs} = (0.41 * 44.573 * (V/Fa)^{0.783})N_r * 2.0 + (Q_D)_{fs}$$

3. Average annual usage

$$(Q_a)_{fs} = [(Q_D)_{fs} + (Q_s)_{fs}]/2.0$$

4. Maximum-day sprinkling usage

$$(Q_{mxs})_{fs} = (1{,}609.59 * B^{0.943} * (V/Fa)^{0.523})N_r$$

5. Maximum-day usage

$$(Q_{mxdy})_{fs} = (Q_D)_{fs} + (Q_{mxs})_{fs}$$

Definition of symbols

Q = water usage for a particular category, gallons per day
V = average home value in a range of value, $1,000

$$V = \frac{V_{min} + V_{max}}{2 * 1{,}000}$$

Fa = assessment factor
D_p = population density per residence
B = irrigable land per dwelling unit, acres per unit
N_r = number of residences in value range r

Subscripts of water use types

fs = flat rate and sewered residential use
D = winter, or domestic, water use
s = summer season use
a = average annual use
mxs = maximum-day sprinkling use
mxdy = maximum-day use

TABLE II-12

FLAT RATE AND UNSEWERED RESIDENTIAL MODELS

1. Winter usage

$(Q_D)_{ft} = (30.2 + 39.5\, D_p)N_r$

2. Summer usage

$(Q_s)_{ft} = (0.41 * 44.573 * (V/Fa)^{0.783})N_r * 2.0 + (Q_D)_{ft}$

3. Average annual usage

$(Q_a)_{ft} = [(Q_D)_{ft} + (Q_s)_{ft}]/2.0$

4. Maximum-day sprinkling usage

$(Q_{mxs})_{ft} = (1{,}609.59 * B^{0.943} * (V/Fa)^{0.523})N_r$

5. Maximum-day usage

$(Q_{mxdy})_{ft} = (Q_D)_{ft} + (Q_{mxs})_{ft}$

Definition of symbols

Q = water usage for a particular category, gallons per day
V = average home value in a range of value, $1,000

$$V = \frac{V_{min} + V_{max}}{2 * 1{,}000}$$

Fa = assessment factor
D_p = population density per residence
B = irrigable land per dwelling unit, acres per unit
N_r = number of residences in value range r

Subscripts of water use types

ft = flat rate and unsewered residential use
D = winter, or domestic, water use
s = summer season use
a = average annual use
mxs = maximum-day sprinkling use
mxdy = maximum-day use

TABLE II-13

MASTER-METERED APARTMENT MODELS

1. Winter usage

$(Q_D)_{ap} = (28.9 + 1.576\ V/Fa + 33.6\ D_p)N_r$

2. Summer usage

$(Q_s)_{ap} = 1.433 * (Q_D)_{ap}$

3. Average annual usage

$(Q_a)_{ap} = [(Q_D)_{ap} + (Q_s)_{ap}]/2.0$

4. Maximum-day sprinkling usage

$(Q_{mxs})_{ap} = (Q_s)\ ap - (Q_D)_{ap}$

5. Maximum-day usage

$(Q_{mxdy})_{ap} = (Q_D)_{ap} + (Q_{mxs})_{ap}$

Definition of symbols

Q = water usage for a particular category, gallons per day
V = average home value in a range of value, $1,000

$$V = \frac{V_{min} + V_{max}}{2 * 1{,}000}$$

Fa = assessment factor
D_p = population density per residence
N_r = number of residences in value range r

Subscripts of water use types

ap = master-metered apartment residential use
D = winter, or domestic, water use
s = summer season use
a = average annual use
mxs = maximum-day sprinkling use
mxdy = maximum-day use

TABLE II-14

COMMERCIAL AND INSTITUTIONAL
CATEGORIES AND WATER USE COEFFICIENTS

Category	Category Name	SIC Codes	Water Use Type	Water Use Coefficient (gallons/ employee/day)
C001	Miscellaneous commercial	All codes not listed below	none	47.2
C002	Vocational school	8243,8244,8249, 8291-99,8331-39, 8611-99	Sr	72.0
C003	Miscellaneous retail	5201-5399,5601-99, 5701-99,5901-99,7031-39, 7833,8231-39	Sp	19.3
C004	Boardinghouses	7021-29,7041-49	Sr,Fr	101.6
C005	Transportation terminal	4171,4581-89	Sp,Fp	86.2
C006	Barbers, cleaning	7212-17,7221-7249	Pa	380.2
C007	Power laundries	7211,7218	B,Pa	276.9
C008	Landscaping	0181-89,0781-0789, 4971-79	Ps	153.1
C009	Miscellaneous wholesale	1501-1799,4172, 4221-39,4959,5001-99, 5111-39,5151-99,7261-69, 7511-39,7549,7601-99, 7811-19,8351-59,8901-99	O	19.1
C010	Recreational facilities	7997	Sr,O	225.5
C011	Food and auto retail	5411-59,5463,5491-5599, 5813,7832,7931-39	Sp,O	31.3
C012	Dance studios	7911-19	Sr,Sp,O	213.0
C013	Hotels, restaurants	5812,7011-19,7992, 7996,7999,8411-19	Sp,Fp,O	186.6
C014	Electric, gas utilities	4911-39,4953,4961-69	B,O	6.7
C015	Public administration	9101-9799	Fe,B,O	70.6
C016	Schools, universities	8211-29	Sr,Fe,Fr,B,O	55.6

TABLE II-14 (Continued)

Category	Category Name	SIC Codes	Water Use Type	Water Use Coefficient (gallons/ employee/day)
C017	Racetracks	7948	Sp,Fe,Fp,B,O	341.5
C018	Laboratories, water utilities	4941-49,4952,5141-49, 7542,8071-8079	Pa,O	80.5
C019	Health services	8081-99	Sr,Pa,O	33.0
C020	Medical offices, bakeries	5462,8011-49	Sp,Pa,O	54.9
C021	Nursing facilities	8051-59	Sr,Sp,Fe, Fr,Pa,O	107.5
C022	Hospitals	8061-69	Sr,Sp,Fe,Fr, Fp,B,Pa,O	82.2
C023	Zoological, etc., gardens	8421-29	Sp,Fe,Fp, Ps,O	720.7

Definition of water use types

Note that codes are assigned where a significant fraction of total water use is for the named special purpose. Water use by employees for sanitary purposes is assumed to be present in all categories. Water use for seasonal purposes such as air conditioning and incidental lawn and shrub irrigation is not separately specified; this use may occur for any SIC code, depending on the type and location of building.

Sr Sanitary use by residents, students, or other defined nonemployee population.
Sp Sanitary use by patrons or general public.
Fe Food preparation use, food served to employees.
Fr Food preparation use, food served to residents, students, or other defined nonemployee population.
Fp Food preparation use, food served to patrons or general public.
B Water use for boiler feed.
Pa Water use as input to production of goods or services, including water incorporated into product, not seasonal in nature.
Ps Water used as input to production of goods or services, including water incorporated into product, seasonal in nature.
O Other water uses, including vehicle washing, floor and driveway cleaning, etc.

Source: Boland et al., 1985 and unpublished reports.

TABLE II-15

INDUSTRIAL CATEGORIES AND WATER USE COEFFICIENTS

Category	SIC Code	1982 Coefficients (Gallons/Employee/Day) Large Establishments	Average Establishments
I001	201	635.2	343.8
I002	2011	477.8	258.6
I003	2013	901.7	488.1
I004	2016	755.8	409.1
I005	2017	371.5	201.1
I006	202	654.8	354.4
I007	203	715.5	387.3
I008	204	1,391.0	753.0
I009	205	147.9	80.1
I010	2051	140.0 [1]	75.8
I011	2052	163.9 [1]	88.7
I012	206	595.8	322.5
I013	207	1,484.0	803.3
I014	208	1,277.3	691.4
I015	2082	2,681.3	1,451.4
I016	2086	602.1	325.9
I017	2087	958.9	519.1
I018	209	1,286.7	696.5
I019	211	250.0 [2]	201.2
I020	212	250.0 [2]	201.2
I021	213	250.0 [2]	201.2
I022	214	250.0 [2]	201.2
I023	221	263.8 [4]	145.6
I024	222	322.7	178.1
I025	223	245.9	135.7
I026	224	263.8 [4]	145.6
I027	225	731.06	403.4
I028	226	1,076.3	593.9
I029	227	980.1	540.9
I030	228	486.5	268.5
I031	229	315.1	173.9
I032	230	24.3 [9]	24.3
I033	241	88.4	41.3 [10]
I034	242	2,384.7 [4]	310.7
I035	243	238.8	41.3 [10]
I036	244	238.8 [11]	41.3 [10]
I037	245	238.8 [11]	41.3 [10]
I038	249	794.9 [5]	103.6
I039	251	151.4 [6]	64.9
I040	252	77.6 [6]	41.3 [10]
I041	253	109.1 [4]	46.8
I042	254	297.8	127.7
I043	259	109.1 [4]	46.8
I044	261	8,303.7	3,518.3

TABLE II-15 (Continued)

Category	SIC Code	1982 Coefficients (Gallons/Employee/Day) Large Establishments	Average Establishments
I045	262	2,194.2	929.7
I046	263	5,827.4	2,461.1
I047	264	526.4 [5]	223.0
I048	265	215.5 [4]	91.3
I049	266	593.8 [4]	251.6
I050	270	37.9 [4]	37.9
I051	281	1,861.3	1,176.6
I052	282	527.2	333.3
I053	283	531.9	336.2
I054	2831	292.2	184.7
I055	2833	1,200.0	758.5
I056	2834	459.4	290.4
I057	284	447.8	283.1
I058	285	402.9	254.7
I059	286	1,796.0	1,135.3
I060	2861	1,796.0 [3]	1,135.3
I061	2865	1,796.0 [3]	1,135.3
I062	2869	1,796.0 [3]	1.135.3
I063	287	1,328.6	839.9
I064	289	712.5	450.1
I065	291	3,780.0	2,638.9
I066	295	559.1	390.3
I067	299	1,217.7	850.1
I068	301	264.7 [4]	87.3
I069	302	78.3	41.3
I070	303	264.7 [4]	87.3
I071	304	264.7 [4]	87.3
I072	306	439.1	144.9
I073	307	624.8	206.2
I074	311	626.9 [7]	60.1
I075	313	626.9 [7]	60.1
I076	314	626.9 [7]	60.1
I077	315	626.9 [7]	60.1
I078	316	626.9 [7]	60.1
I079	317	626.9 [7]	60.1
I080	319	626.9 [7]	60.1
I081	321	375.1 [4]	156.6
I082	322	332.4	138.8
I083	323	375.1 [4]	156.6
I084	324	375.1 [4]	156.6
I085	325	576.8	240.8
I086	326	210.7	88.0
I087	327	440.3	183.8
I088	328	652.3	272.4
I089	329	375.1 [4]	156.6
I090	331	550.6	348.3

TABLE II-15 (Continued)

Category	SIC Code	1982 Coefficients (Gallons/Employee/Day) Large Establishments	Average Establishments
I091	3312	537.0	339.7
I092	3313	365.3	231.1
I093	3315	435.9	275.7
I094	3316	467.8	295.9
I095	3317	982.5	621.5
I096	332	842.4	532.9
I097	3321	1,077.5	681.6
I098	3322	608.8 [4]	385.1
I099	3324	608.8 [4]	385.1
I100	3325	311.3	196.9
I101	333	259.6	164.2
I102	334	684.9	433.2
I103	335	479.0	303.0
I104	336	292.2	184.8
I105	339	913.2	577.7
I106	341	723.7	301.9
I107	342	231.7	96.7
I108	343	706.1	294.6
I109	344	329.4	137.4
I110	3441	256.1 [4]	106.8
I111	3442	373.6	155.9
I112	3443	378.9	158.1
I113	3444	202.9	84.6
I114	3446	256.1 [4]	106.8
I115	3448	256.1 [4]	106.8
I116	3449	256.1 [4]	106.8
I117	345	293.5	122.4
I118	346	240.6	100.4
I119	3462	525.1	219.1
I120	3463	1,009.4	421.1
I121	3465	150.7	62.9
I122	3466	168.4 [4]	70.3
I123	3469	168.4 [4]	70.3
I124	347	1,019.4	425.3
I125	348	136.2	56.8
I126	349	245.9	102.6
I127	351	168.8 [5]	66.1
I128	352	1,281.5 [4]	501.7
I129	353	103.4	41.3 [10]
I130	3531	113.5 [4]	44.4
I131	3532	113.5 [4]	44.4
I132	3533	79.7	41.3 [10]
I133	3534	113.5 [4]	44.4
I134	3535	113.5 [4]	44.4
I135	3536	113.5 [4]	44.4
I136	3537	113.5 [4]	44.4

TABLE II-15 (Continued)

Category	SIC Code	1982 Coefficients (Gallons/Employee/Day) Large Establishments	Average Establishments
I137	354	107.0	41.9
I138	355	250.3 [5]	98.0
I139	356	149.6	58.6
I140	357	108.1	42.3
I141	3572	108.1 [8]	42.3
I142	3573	108.1 [8]	42.3
I143	3574	108.1 [8]	42.3
I144	3576	108.1 [8]	42.3
I145	3579	108.1 [8]	42.3
I146	358	356.8	139.7
I147	3581	119.1 [4]	46.6
I148	3582	119.1 [4]	46.6
I149	3585	374.2	146.5
I150	3586	182.6	71.5
I151	3589	119.12[4]	46.6
I152	359	165.8 [5]	64.9
I153	3592	186.18[4]	72.9
I154	3599	99.62	39.0
I155	361	251.9	145.2
I156	362	329.4	189.9
I157	363	298.0	171.8
I158	364	221.7	127.8
I159	365	196.5 [4]	113.3
I160	366	80.2	46.2
I161	367	228.4	131.7
I162	3671	294.5 [4]	169.8
I163	3672	228.4 [8]	131.7
I164	3673	228.4 [8]	131.7
I165	3674	239.5	138.1
I166	3675	115.1	66.4
I167	3676	168.59[4]	97.2
I168	3677	228.4 [8]	131.7
I169	3678	127.9	73.7
I170	3679	241.6	139.3
I171	369	196.5 [4]	113.3
I172	371	299.9	217.9
I173	3711	280.86[4]	204.0
I174	3713	280.86[4]	204.0
I175	3714	320.4	232.8
I176	3715	299.9 [8]	217.9
I177	372	151.6 [4]	110.1
I178	3721	151.6 [8]	110.1
I179	3724	151.6 [8]	110.1
I180	3728	151.6 [8]	110.1
I181	373	151.6 [4]	110.1
I182	374	294.9	214.2

TABLE II-15 (Continued)

Category	SIC Code	1982 Coefficients (Gallons/Employee/Day) Large Establishments	Average Establishments
I183	375	456.6	331.7
I184	376	140.9	102.4
I185	379	234.8	170.6
I186	381	91.3	43.7
I187	382	109.7	52.6
I188	383	122.1 [4]	58.5
I189	384	122.1 [4]	58.5
I190	385	122.1 [4]	58.5
I191	386	122.1 [4]	58.5
I192	387	122.1 [4]	58.5
I193	391	203.8 [4]	93.9
I194	393	203.8 [4]	93.9
I195	394	240.7	110.9
I196	395	222.1	102.4
I197	396	203.8 [4]	93.9
I198	399	203.8 [4]	93.9

Notes:

[1] If no public intake is reported for a four-digit SIC category, the four-digit level assumes the same public/total intake ratio as the three-digit level.

[2] Since public intake is not reported for category 21, the ratio of public/total intake observed in 1977 is assumed for 1982 and is applied to three-digit categories 211, 212, 213, and 214.

[3] A coefficient is estimated for SIC 286; however, no information is provided for its four-digit categories. Therefore, three-digit coefficient is assumed for the four-digit level.

[4] Three-digit coefficients are estimated as total water use for two-digit SIC category, less reported (or estimated) three-digit water use divided by corresponding employment.

[5] If no public intake is reported, the category assumes the public/total intake ratio as observed in 1977.

[6] Three-digit public/total ratio is same as that for two-digit SIC category.

[7] Where no three-digit SIC information is available, a two-digit coefficient is assumed.

[8] Where no four-digit SIC information is available, a three-digit coefficient is assumed.

[9] Estimated from an independent survey. SIC 23 is based on a sample of three establishments with 145 employees. SIC 27 is based on a sample of five establishments with 1,873 employees.

[10] Coefficient represents average sanitary use derived from the 1982 survey.

[11] SIC 244 and 245 are assumed to reflect a water use pattern similar to SIC 243.

Source: U.S. Bureau of the Census, 1986, and a special tabulation by the U.S. Bureau of the Census (see page II-40 for explanation).
*G/E/D = gallons per employee per day.

TABLE II-16

PUBLIC/UNACCOUNTED CATEGORIES AND WATER USE COEFFICIENTS

Category	Category Name	Parameter	Average Annual Coefficients
FLSS	Distribution loss (percent)	Total water use	0.15
LOSS	Distribution loss (per capita)	Population	14.90 GPD
FSER	Free service (per capita)	Population	5.20 GPD

GPD = gallons per person per day.

4.2 PARAMETER PROJECTION METHODS

For each forecast year, water use is calculated as a function of water use parameters (e.g., housing units, marginal price, employment). Some of these parameters are projected to the forecast year for which water use is to be estimated. The IWR-MAIN System provides three alternative methods for projecting future values of the determinants of water use. Parameters which can be projected are:

(1) Projection by internal growth models
(2) Projection by extrapolation of local historical data provided by the users
(3) Use of projections made external to the IWR-MAIN System, as provided by the user

In general, for each forecast year, and for each projected parameter, the projection method may be selected independently of other parameters and other years. A considerable range of options are available for each forecast year. At the minimum, the user may supply only population, total employment, and median household income for the forecast year, and IWR-MAIN will internally generate values for all other projected parameters.

When several different projection options are employed for a given year, the possibility of conflicts or inconsistent assumptions must be considered. IWR-MAIN resolves these internal conflicts by a system of priorities. In general, the external projections supersede those made by extrapolation of historical trends, which, in turn, supersede those made by the internal growth models.

Projections Made External to the IWR-MAIN System

Situations may frequently arise where some degree of knowledge is available on the likely growth of specific parameters. This may come about because of a detailed study which has been made of some aspect of the community's economy, or because of plans on the part of an industry or commercial enterprise to expand, relocate, or phase out an operation. In any of these situations, it is desirable to bypass alternative methods of projecting parameter values and to provide the projected value of the affected parameters directly from sources external to the IWR-MAIN System. This capability is available by simply providing projections of the selected water use parameters.

The external projection option in the IWR-MAIN System has a secondary purpose that, in many applications, may overshadow the first in importance. Use of the internal growth models, or projection by extrapolation of historical trends, yields a deterministic set of projections which are used to estimate a deterministic set of water requirements. All urban or water supply planners are familiar with the large uncertainties implicit in all projections. One useful method of exploring those uncertainties is by testing the sensitivity of the final forecast to ranges of values for various critical projections. Tests of this type can be carried out by using the external projection option of the IWR-MAIN System. The recommended procedure is to process the IWR-MAIN System in the normal manner and review the output reports, thus determining which parameters appear the most significant in affecting overall water requirements and which parameter values appear suspect in the judgment of the system user. A second run is made with each forecast year repeated several times (e.g., 1990, 1990, 1990, 1995, 1995, 1995). Each iteration of each forecast year contains direct external projections of those parameters previously identified as critical or suspect, with a range of values constructed to represent the range of reasonable parameter estimates utilized over the various iterations. In this manner, a range of water requirement forecasts will result for each forecast year which embraces the probable variation in the parameters studied.

Projection by Extrapolation of Local Historical Data

In the course of applying the IWR-MAIN System, many situations will arise where no special knowledge of the future growth of a given parameter is available, yet there are good reasons for believing that the internal growth projections made within the IWR-MAIN System will be inappropriate. In a resort city, for example, the

growth of hotels and motels cannot be predicted from growth experienced in otherwise similar cities which are commercially or industrially oriented. Problems of this type arise when the study area is not a self-sufficient community, or when a particular industry so dominates a community that fluctuations in its national market affect the growth of other businesses and services. In each of these cases, provided no other information is available, it is usually prudent to base projections on a simple extrapolation of recent trends, rather than to rely on the internal growth models.

Where this projection option is utilized, additional data must be gathered for the study area. Values must be provided for the parameter for at least two, but not more than seven, different years. One of these years may be the base year. It is usually desirable to provide as many data points as possible, particularly if the historical trend of the parameter has not been linear. Historical data may be provided for components of each municipal sector; for example, data may be provided for housing categories, commercial categories, industrial categories, and public/unaccounted categories.

Projection by Internal Growth Models

The GROWTH Subroutine

IWR-MAIN in its present version (5.1) contains a fully operative and complete internal parameter projection capability. This internal capability is incorporated into the GROWTH subroutine of the IWR-MAIN System. In past versions (2.0 to 2.4) this GROWTH subroutine was limited for certain uses only. Versions 3.0, 3.1, and 3.2 contained no internal forecasting procedures pending completion of the research which went into version 4.0. In its present form, the GROWTH subroutine provides internal projections of the following parameters:

(1) Total number of housing units
(2) Number of housing units per category
(3) Number of housing units per value range
(4) Employment per major industry group
(5) Employment per commercial/institutional category
(6) Employment per industrial category

GROWTH also contains logic which gives precedence to any direct external or historical extrapolation projections (if supplied). Since consistency and interrelationships among projections are also important, it is necessary to adjust values of internal projections based on external values supplied by the user. Therefore, the final set of projections makes the best use of all information supplied.

Data Collection

The GROWTH subroutine derives its internal projections from econometric models of changes in housing and employment. These models were estimated from data collected at the Standard Metropolitan Statistical Area (SMSA) level by the U.S. Bureau of the Census. Housing, demographic, and economic data were used to estimate the housing equations, while the employment equations were based on employment data.

Housing data were collected for the years 1960, 1970, and 1980 for each of the counties and independent cities included in the 318 SMSAs defined for the 1980 Census. Employment data were obtained for the years 1972, 1977, and 1982 for the 318 SMSAs. Employment was disaggregated by major 1972 Standard Industrial Classification (SIC) categories using the U.S. Bureau of the Census' Economic Census series (Census of Manufacturing, Census of Retail Trade, etc.) and the U.S. Bureau of the Census' County Business Patterns. The following major industry groups were used:

(1) Total employment (except mining, forestry, and agriculture)
(2) Total construction employment (SIC 15-17)
(3) Total manufacturing employment (SIC 20-39)
(4) Total transportation, communication, and utility employment (SIC 40-49)
(5) Total wholesale employment (SIC 50-51)
(6) Total retail employment (SIC 52-59)
(7) Total finance and banking employment (SIC 60-67)
(8) Total services employment (SIC 70-89)
(9) Total government employment (SIC 90-99)

In addition, within each major industry group, employment at the two-digit SIC category level was also obtained.

Projection Models

The projection models used in the GROWTH subroutine were estimated from available data using ordinary least squares regression analysis. Equations were estimated in both linear and log-linear forms, at various levels of aggregation, and were specified in a number of alternate forms. Out of some several hundred regression runs, the equations which provided the best combinations of explanatory power and suitability with respect to data requirements were selected for inclusion in the IWR-MAIN System. The models used to internally project water use parameters are described in the following subsections.

Housing Models. The equations selected for the residential sector project the following variables:

(1) PGRP1 -- percent of total housing units with forecast year market value less than $25,000 expressed in 1980 dollars (value group 1)
(2) PGRP2 -- percent of total housing units with forecast year market value at least $25,000, but less than $50,000 expressed in 1980 dollars (value group 2)
(3) PGRP3 -- percent of total housing units with forecast year market value at least $50,000, but less than $100,000 expressed in 1980 dollars (value group 3)
(4) PGRP4 -- percent of total housing units with forecast year market value at least $100,000 expressed in 1980 dollars (value group 4)
(5) MWG1, MWG2, MWG3, MWG4 -- number of metered and sewered housing units in value groups 1, 2, 3, and 4, respectively
(6) FWG1, FWG2, FWG3, FWG4 -- number of flat rate and sewered housing units in value groups 1, 2, 3, and 4, respectively
(7) FPG1, FPG2, FPG3, FPG4 -- number of flat rate and unsewered housing units in value groups 1, 2, 3, and 4, respectively
(8) APG1, APG2, APG3, APG4 -- number of master-metered apartment housing units in value groups 1, 2, 3, and 4, respectively
(9) MWTL, FWTL, FPTL, APTL -- total number of housing units in metered and sewered, flat rate and sewered, flat rate and unsewered, and master-metered apartment categories, respectively
(10) HTOT -- total number of housing units (all categories)

The econometric projection equations selected for inclusion in the GROWTH subroutine are:

$$PGRP1 = 69.035 - 4.209*CCOD - 0.002627*TICOM_f + 30.0*PICOM - 0.120*PPOPU \quad (1)$$

$$PGRP2 = -91.235 + 0.779*CCOD - 0.000814*TICOM_f + 1.247*ICO1 + 1.236*ICO2 + 3.153*ICO3 \quad (2)$$

$$PGRP2 = 74.674 - 3.248*CCOD - 0.001757*TICOM_f - 5.9*PPOPU \text{ (alternative)} \quad (2a)$$

$$PGRP3 = -22.301 + 3.854*CCOD + 0.002888*TICOM_f + 13.9*PPOPU - 21.2*PICOM \quad (3)$$

$$PGRP4 = 100.00 - PGRP1 - PGRP2 - PGRP3 \quad (4)$$

$$HTOT_f = -2384.441 + 0.364 * POPU_f \quad (5)$$

where subscripts b and f refer to base and forecast years, respectively,

and

CCOD = 1 if study area contains central city; = 0 otherwise
CDAT = base year
FDAT = forecast year
POPU = resident population
TICOM = median household income expressed in 1980 dollars
PPOPU = $(POPU_f/POPU_b)^{10/(FDAT-CDAT)}$
PICOM = $(ICOM_f/ICOM_b)^{10/(FDAT-CDAT)}$
IC01 = fraction of households with income less than $10,000 expressed in 1980 dollars
IC02 = fraction of households with income at least $10,000, but less than $20,000 expressed in 1980 dollars
IC03 = fraction of households with income at least $20,000, but less than $30,000 expressed in 1980 dollars

The following equations describe the relationships among projected parameters and illustrate the way in which the results of the econometric models are used to generate the complete set of projected parameters.

$$HTOT_b = MWTL_b + FWTL_b + FPTL_b + APTL_b \quad (6)$$

$$MWTL_f = (HTOT_f/HTOT_b) * MWTL_b \quad (7)$$

$$FWTL_f = (HTOT_f/HTOT_b) * FWTL_b \quad (8)$$

$$FPTL_f = (HTOT_f/HTOT_b) * FPTL_b \quad (9)$$

$$APTL_f = (HTOT_f/HTOT_b) * APTL_b \quad (10)$$

$$MWG1_f = (MWG1_b/(MWG1_b + FWG1_b + FPG1_b + APG1_b)) * HTOT_f * (PGRP1/100.) \quad (11)$$

$$FWG1_f = (FWG1_b/(MWG1_b + FWG1_b + FPG1_b + APG1_b)) * HTOT_f * (PGRP1/100.) \quad (12)$$

$$FPG1_f = (FPG1_b/(MWG1_b + FWG1_b + FPG1_b + APG1_b)) * HTOT_f * (PGRP1/100.) \quad (13)$$

$$APG1_f = (APG1_b/(MWG1_b + FWG1_b + FPG1_b + APG1_b)) * HTOT_f * (PGRP1/100.) \quad (14)$$

$$MWG2_f = (MWG2_b/(MWG2_b + FWG2_b + FPG2_b + APG2_b)) * HTOT_f * (PGRP2/100.) \quad (15)$$

$$FWG2_f = (FWG2_b/(MWG2_b + FWG2_b + FPG2_b + APG2_b)) * HTOT_f * (PGRP2/100.) \quad (16)$$

$$FPG2_f = (FPG2_b/(MWG2_b + FWG2_b + FPG2_b + APG2_b)) * HTOT_f * (PGRP2/100.) \quad (17)$$

$$APG2_f = (APG2_b/(MWG2_b + FWG2_b + FPG2_b + APG2_b)) * HTOT_f * (PGRP2/100.) \quad (18)$$

$$MWG3_f = (MWG3_b/(MWG3_b + FWG3_b + FPG3_b + APG3_b)) * HTOT_f * (PGRP3/100.) \quad (19)$$

$$FWG3_f = (FWG3_b/(MWG3_b + FWG3_b + FPG3_b + APG3_b)) * HTOT_f * (PGRP3/100.) \quad (20)$$

$$FPG3_f = (FPG3_b/(MWG3_b + FWG3_b + FPG3_b + APG3_b)) * HTOT_f * (PGRP3/100.) \quad (21)$$

$$APG3_f = (APG3_b/(MWG3_b + FWG3_b + FPG3_b + APG3_b))*HTOT_f*(PGRP3/100.) \quad (22)$$

$$MWG4_f = (MWG4_b/(MWG4_b + FWG4_b + FPG4_b + APG4_b))*HTOT_f*(PGRP4/100.) \quad (23)$$

$$FWG4_f = (FWG4_b/(MWG4_b + FWG4_b + FPG4_b + APG4_b))*HTOT_f*(PGRP4/100.) \quad (24)$$

$$FPG4_f = (FPG4_b/(MWG4_b + FWG4_b + FPG4_b + APG4_b))*HTOT_f*(PGRP4/100.) \quad (25)$$

$$APG4_f = (APG4_b/(MWG4_b + FWG4_b + FPG4_b + APG4_b))*HTOT_f*(PGRP4/100.) \quad (26)$$

Employment Models. A projection of total employment is made by calculating the compound rate of growth (expressed as fraction per five years) implied by total employment data given for base and forecast years. This growth rate is applied to the base year employment total to obtain employment projections for the end of each five-year period.

The employment equations are used to estimate the percent of total employment in each of the major employment sectors:

(1) PEMP2 -- percent of total employment in construction industries (SIC 1500-1799)
(2) PEMP3 -- percent of total employment in manufacturing industries (SIC 2000-3999)
(3) PEMP4 -- percent of total employment in transportation, communication, and utilities industries (SIC 4000-4999)
(4) PEMP5 -- percent of total employment in wholesale trade (SIC 5000-5199)
(5) PEMP6 -- percent of total employment in retail trade (SIC 5200-5999)
(6) PEMP7 -- percent of total employment in finance industries (SIC 6000-6799)
(7) PEMP8 -- percent of total employment in service industries (SIC 7000-8999)
(8) PEMP9 -- percent of total employment in government (SIC 9000-9999)

The econometric projection equations selected for inclusion in the GROWTH subroutine are:

$$PEMP2 = 3.092 + 0.038*(EMP2_{-5}/EMPL_{-5}) + 0.366*(EMP2_{-10}/EMPL_{-10}) \quad (27)$$

$$PEMP3 = 8.027 + 0.414*(EMP3_{-5}/EMPL_{-5}) + 0.220*(EMP3_{-10}/EMPL_{-10}) \quad (28)$$

$$PEMP4 = 3.199 + 0.272*(EMP4_{-5}/EMPL_{-5}) + 0.187*(EMP4_{-10}/EMPL_{-10}) \quad (29)$$

$$PEMP5 = 5.039 + 0.014*(EMP5_{-5}/EMPL_{-5}) + 0.442*(EMP5_{-10}/EMPL_{-10}) \quad (30)$$

$$PEMP6 = 18.145 + 0.176*(EMP6_{-5}/EMPL_{-5}) + 0.062*(EMP6_{-10}/EMPL_{-10})\ 0.000007*EMPL_b \quad (31)$$

$$PEMP7 = 2.958 + 0.342*(EMP7_{-5}/EMPL_{-5}) + 0.122*(EMP7_{-10}/EMPL_{-10}) + 0.000002*EMPL_b \quad (32)$$

$$PEMP8 = 15.315 + 0.363*(EMP8_{-5}/EMPL_{-5}) + 0.112*(EMP8_{-10}/EMPL_{-10}) \quad (33)$$

$$PEMP9 = 5.841 + 0.306*(EMP9_{-5}/EMPL_{-5}) + 0.205*(EMP9_{-10}/EMPL_{-10}) - 0.000003*EMPL_b \quad (34)$$

Where subscripts -5 and -10 refer to periods five years and ten years before base year, respectively,

and

EMPL = total employment in the study area
EMP2 = employment in construction industries (SIC 1500-1799)
EMP3 = employment in manufacturing industries (SIC 2000-3999)
EMP4 = employment in transportation, communication, and utilities industries (SIC 4000-4999)

EMP5 = employment in wholesale trade (SIC 5000-5199)
EMP6 = employment in retail trade (SIC 5200-5999)
EMP7 = employment in finance industries (SIC 6000-6799)
EMP8 = employment in service industries (SIC 7000-8999)
EMP9 = employment in government (SIC 9000-9999)

Note that user-added commercial category parameters may be specified as either an employment or a user-specified parameter. If the employment parameter is used, then the internal growth subroutine will generate parameter projections for those categories. Otherwise, the user must provide the parameter projections for each forecast year in the external projection screens. Parameter projections for the public user-added categories will be generated based on a ratio of base year to forecast year population.

4.3 CONSERVATION METHODS

The Conservation Effectiveness Algorithm

Water conservation measures have the effect of reducing water use and thus become an integral part of the forecast. The methodology followed in the determination of the effectiveness of conservation measures is described in a manual prepared for the U.S. Corps of Engineers (Baumann et al., 1980). This manual describes the concepts, procedures, and measurement techniques applicable to the development and evaluation of water conservation programs.

There are three important parameters in the determination of effectiveness of each measure: (1) the fraction reduction in water use (R), (2) the coverage or market penetration (C), and (3) the projected water use without conservation (Q). These parameters are used in the equation:

$$E_{msdt} = R_{msd} * C_{mst} * Q_{std} \quad (1)$$

where

E_{msdt} = the effectiveness of measure m (e.g., plumbing code) in water use dimension d (e.g., indoor) in sector s (e.g., residential metered and sewered) at time t (e.g., year 1990), measured in gallons per day or other suitable units.

R_{msd} = the fraction reduction in the use of water for the dimension of water use d (e.g., indoor use) for sector s (e.g., residential metered and sewered) expected as a result of implementing measure m (e.g., conservation-oriented plumbing code).

C_{mst} = the coverage of measure m in use sector s at time t expressed as a fraction of sectorial water use; e.g., if a plumbing code is implemented in the community on January 1, 1987, then the coverage value for the residential metered and sewered sector (s) in the future year (t) is defined as the proportion of the sector water use occurring in dwelling units built since the implementation date. This can be approximated by the ratio of the new housing units to the total projected number of units for that year.

Q_{std} = the projected unrestricted water use for the dimension of water use d in sector s at time t in quantity per unit time (million gallons per day or acre-feet per year).

The water use dimensions for conservation are indoor, outdoor, and maximum-day sprinkling use. The three components of effectiveness are estimated with the following considerations: (1) reduction factors are specific for each measure, sector, and dimension; (2) coverage factors are specific for each measure, sector, and time period; and (3) unrestricted water demand is specific for each sector, dimension, and time period. Thus, the effectiveness of a measure is specific for each measure, sector, dimension, and time period.

A precise evaluation of each of the three parameters for each community, water use sector, dimension, and time period is critically important for the proper evaluation of the expected water savings (E_{msdt}) that will occur upon the implementation of each measure.

This estimation technique requires information on the prevailing habits and patterns of water use in the study area. Water-using activities inside and outside residential homes, business buildings, and other facilities must be known in order to compare the anticipated reduction in water use for a typical nonconserving household or establishment. The annual indoor and outdoor residential water use estimates are derived from the IWR-MAIN forecasts of residential winter and summer water use with winter use equal to indoor use and summer use minus winter use equal to outdoor use. Calibration procedures used in preparation of the demand forecast allow the user to adjust the residential winter and summer forecasts to prevailing habits and patterns of water use in the study area (see section 5.3). Indoor water use for the nonresidential sectors requires the multiplication of annual water use by a factor representing the percentage of total water use which is used indoors for each nonresidential sector in the study area.

In order to obtain further disaggregation of indoor use, it is usually necessary to use the results of the studies of the intensity and frequency of fixture or appliance use conducted in the study area or in other areas of the country. The typical frequencies and intensities of fixture use have to be defined for conserving and nonconserving households, commercial establishments, and other types of users (see Brown and Caldwell, 1984). This information is utilized in the determination of the fraction reduction in water use to be achieved by the implementation of a specific water conservation measure.

Active water conservation programs often involve the application of more than one water conservation measure to a given municipal sector. In this situation, the effectiveness of each additional measure is adjusted by an interaction factor which accounts for the interaction between various measures. This interaction causes the effectiveness of the combined measures to be different than if each measure were considered separately (see Richards, McCall, and Deb, 1984).

The combined effectiveness of conservation measures for a given sector is calculated as:

$$E_{123} = E_1 + (a_{12} * E_2) + (a_{13} * a_{23} * E_3) \quad (2)$$

where

E_{123} = the combined effectiveness of measures 1, 2, and 3
E_1 = the effectiveness of measure 1 when implemented alone
E_2 = the effectiveness of measure 2 when implemented alone
E_3 = the effectiveness of measure 3 when implemented alone
a_{12} = the interaction factor for measure 2 added to measure 1
a_{13} = the interaction factor for measure 3 added to measure 1
a_{23} = the interaction factor for measure 3 added to measure 2

Two or more conservation measures, each of which affects different water use dimensions and/or different sectors, show no interaction and thus have an interaction factor of 1.0. For example, plumbing codes affecting residential indoor water use and an ordinance restricting lawn size affecting residential outdoor use would have an interaction factor of 1.0. However, the effectiveness of each of these two measures may be diminished (or preempted) by the effects of an educational campaign directed at modifying water use behaviors both indoor and outdoor. Interaction factors are estimated with consideration of all possible pairings of measures for each of the three water use dimensions (indoor, outdoor, and maximum-day).

Actual computation of conservation effectiveness by IWR-MAIN consists of the calculation of a conservation adjustment factor for each sector and dimension which is then used to calculate the water use as restricted by the specified combination of conservation measures (restricted water use) for each sector and dimension. The formulas used are:

$$P_{s,d} = \sum_{m=1}^{n} (R_{m,s,d} * C_{m,s,t} * I_{m,m+j,d}) \quad (3)$$

and

$$Q_{c,s,d} = Q_{u,s,d} (1 - P_{s,d}) \quad (4)$$

where

t	=	the year for which the forecast is being calculated
m	=	a measure applicable in the current year, sector, and dimension
n	=	the number of applicable measures
s	=	water use sector
d	=	dimension of water use
$P_{s,d}$	=	the adjustment factor for the effect of all applicable measures for sector s and dimension d
$R_{m,s,d}$	=	reduction factor for measure m, sector s, and dimension d
$C_{m,s,t}$	=	coverage factor for measure m and sector s for current year t
$I_{m,m+j,d}$	=	interaction factor for the combination of measures m and m+j for dimension d, where j = 1 through n
$Q_{u,s,d}$	=	unrestricted water use for sector s and dimension d
$Q_{c,s,d}$	=	restricted water use for sector s and dimension d

Again, because conservation measures may affect either indoor use, outdoor use, or both, unrestricted water use for the residential sectors is converted from winter, summer, annual, and maximum-day use to indoor, outdoor, and maximum-day use for application in the conservation algorithm. Indoor use equals winter use, outdoor use equals summer use minus winter use, and maximum-day use remains the same (maximum-day sprinkling use plus winter use). Unrestricted water use for the commercial, industrial, and public sectors is multiplied by an indoor factor from the Library of Conservation Coefficients (LCC) to produce the indoor use for each of these sectors. The indoor factors are set at 0.80, implying that 80 percent of water use in each of these sectors is indoor use. These values may be changed in the LCC using any text editor (see section 4.4). Particularly, the public sector indoor/outdoor factor should be reduced when public sector user categories (screen 8.2) are used which include swimming pools or the irrigation of parks or school sports fields. Once the restricted water use has been determined for each sector, the conversion process is reversed to produce restricted water use estimates for each sector using the same dimensions as shown in the output reports (winter, summer, annual, and maximum-day).

Description of the Conservation Measures

There are 14 specific water conservation measures and four additional user-specified measures listed in Data Entry Screen 15.1. The following is a brief description of the 14 specific measures followed by a discussion of reduction, coverage, and interaction factors for each measure.

Public Education Program

Public education programs typically consist of direct mail campaigns, news media campaigns, and/or special events. Direct mail campaigns refer to the mailing of water conservation literature or "bill stuffers" to customers. News media campaigns include the provision of material to newspapers and the use of radio and television to disseminate information on water conservation. Special events include lectures, films, and programs for school and civic groups.

Metering

Metering as a water conservation measure refers to the installation of water-metering devices on previously unmetered residential, commercial, industrial, or other connections.

Pressure Reduction

Installation of pressure-reducing valves in service lines can affect all sectors and dimensions. However, if there are concerns about pressure in a given area the measures may only be applicable to new construction.

Pricing Policy (Rate Reform)

Water conservation by metered customers can be promoted via changes in price structures or rates. The calculation of the reduction factor for a change in pricing policy requires knowledge of the price elasticity for the service area by sector and dimension, as well as the magnitude and type of change in prices. See the discussion of reduction factors for details.

Rationing

Rationing is typically used as an emergency water conservation measure which restricts the total quantity used by a customer. Although no restrictions are imposed regarding types of water usage, fines may be imposed for noncompliance with the limit on total quantity used.

Sprinkling Restriction

Sprinkling restrictions represent restrictions, or bans, on specific uses of water. These are temporary restrictions on outdoor water use applicable to the residential, commercial, industrial, and public sectors. Restrictions may include the avoidance of runoff from landscape irrigation, limiting of such irrigation to alternate days, and limiting the outdoor use to the hours from midnight to noon.

Industrial Reuse/Recycle

Implementation of the industrial reuse/recycle measure promotes the use of cost-effective water-saving technologies in industrial processes. This measure can be targeted toward existing industrial customers not currently using such technologies, as well as targeting new industries locating within the service area.

Commercial Reuse/Recycle

Reuse or recycling of water used in commercial processes can be achieved in a manner similar to that used in the industrial sector.

Leak Detection and Repair

Leak detection and repair as a conservation measure address unaccounted water use. Detection of leaks and the repair and replacement of pipelines can reduce losses and lower the percent of total production which is not accounted for by the metering records.

Retrofit of Showerheads and Toilets

The installation of low-flow showerheads and toilet dams (or inserts) in all structures with nonconserving fixtures will reduce indoor water use in the residential, commercial, industrial, and other sectors.

Moderate Plumbing Code

Plumbing codes requiring water-saving devices for all new construction can reduce water demand in residential indoor use. Moderate water-saving devices include low-flow showerheads using a maximum of 3.0 gallons per minute, low-flush toilets using 3.5 gallons per flush cycle, low-flow faucets using a maximum of 2.75 gallons per minute, and water-efficient dishwashers.

Advanced Plumbing Code

Plumbing codes for all new construction requiring advanced water- saving devices can further reduce interior use from the reduction brought about by the moderate plumbing code measure. Advanced water-saving devices include low-flow showerheads using a maximum of 0.5 gallons per minute and low-flush toilets using 0.5 gallons per flush cycle. Implementation of the advanced plumbing codes is assumed to follow the implementation of the moderate plumbing code measure. In the event that a study area does not have requirements for moderate water-saving devices in the plumbing code, but the impact of requiring advanced water-saving devices is to be assessed, the user should specify both the moderate and advanced plumbing code measures in order to measure the full impact of the transition from nonconserving to advanced devices.

Low Water-Using Landscapes for New Construction

Water used for landscape irrigation comprises the majority of outdoor water use and accounts for much of the increase in water consumption during maximum-use days. Reduction of water required by turf and landscape plants via the use of low water-using plants and grasses can be encouraged in new construction through the offering of reduced connection fees, or be mandated through city ordinances or other statutes.

Low Water-Using Landscapes for Existing Areas

Municipalities can encourage the conversion of traditional high water-using landscapes to water-conserving landscapes through contests, education programs, and demonstration gardens, as well as through the offering of tax rebates for retrofitted landscapes.

Reduction Factors

Reduction factors measure the percent reduction in water use for a given water use sector and dimension which is expected to result from a given conservation practice. For example, the percent reduction associated with the implementation of plumbing codes requiring installation of low-flow showerheads and low water-using toilets is calculated as:

$$R = (S/Q_{in}) \quad (5)$$

where

- R = the fraction reduction of average daily indoor residential use
- S = the water savings resulting from installation of conserving devices, gallons per person per day
- Q_{in} = the average residential indoor water use, gallons per person per day

Reduction factors calculated for a specific study area may be entered through screens 16.1, 16.2, 16.3, and 16.4 by dimension (indoor, outdoor, and maximum-day use) for the measures and sectors specified on screens 15.1 and 15.2, respectively. Reduction factors not provided for the specified measures and sectors will be obtained from the Library of Conservation Coefficients (LCC). The reduction factors in the LCC are arranged by measure, dimension, and sector. The values in the LCC are shown in Table II-17. These values are based on a review of water conservation literature. The values for measures, sectors, and dimensions not shown in Table II-17 are zero. The reduction factor values specified through the data input screens will override the values in the LCC and are saved in the data files. Thus, if site-specific values are available, modification of the reduction factor values in the LCC is not necessary, although this is possible using a text editor. Reduction factors must be between 0.0 and 1.0.

In addition to the information provided in Table II-17, further explanation of the reduction factors for some of the measures follows.

Pricing Policy

The fraction reduction in water use for each sector is found by the following expression:

$$R_{msd} = 1 - \left(\frac{P_2}{P_1} \right)^e \qquad (6)$$

where

R_{msd} = fraction reduction in water use for dimension d in sector s as a result of implementing measure m
P_1 = marginal price faced by users in sector s and dimension d, without change in price structure
P_2 = marginal price faced by users in sector s and dimension d, with change in price structure
e = price elasticity of demand for sector s and dimension dincluding the effects of bill difference where applicable

The percent change in price (P_2/P_1) must be determined for the specific application (study area). Note that the changes in indoor and outdoor water use dimensions should be related to winter and summer prices, respectively. If there is significant outdoor winter water use in a study area, then P_1 and P_2 for the outdoor use dimension should be determined by weighing the winter and summer prices by the distribution of winter and summer outdoor use. Similarly, if there are price blocks for a given sector, the percent change in price for the sector is determined by weighing the percent change in price for each block by the distribution of customers by blocks. The assumed change in price used in the calculation of values for the LCC was 50 percent.

Estimates of the price elasticities by sector and dimension may be calculated for the specific area. Boland et al. (1984) reviewed more than 50 studies on the effect of price on water use and provided estimated ranges of price elasticity of water demand by sector and dimension. From these estimated ranges, the midpoints were selected for the calculation of the reduction factors for pricing policy in the LCC. The ranges and selected elasticities are:

Sector and Dimension	Range	Selected Elasticity
Residential winter use	0.0 to -0.10	-0.06
Residential summer use		
Eastern U.S.	-0.50 to -0.60	-0.57
Western U.S.	n/a	-0.52

Commercial			
	Individual	-0.20 to -1.40	-0.80
	Aggregate	n/a	
Industrial			
	Individul	-0.30 to -6.71	
	Aggregate	-0.50 to -0.80	-0.65

Baumann et al. (1981) suggest that the reduction in residential maximum-day water use with respect to price changes is 1.8 times the reduction of residential summer use (p. 192). Thus, once the reduction factors for the summer dimension of the residential sectors have been determined, the reduction factors for the maximum-day dimension can be calculated.

Rationing

Water-rationing goals are specified in terms of the percent reduction desired in water use per sector. Richards et al. (1984) report the relationship of achieved reduction to reduction goals as:

$$R = 0.115 + 0.732\ (GOAL) \qquad (7)$$

where the value for GOAL is the desired percent reduction expressed as a fraction.

This formula is used to convert the desired reduction goal per sector into the corresponding reduction factors. Summer reduction is assumed for maximum-day. The reduction goal of 20 percent reduction (0.20) was assumed for the value in the LCC, thus producing a reduction factor of 0.261. This reduction is assumed constant across all sectors except unaccounted.

Leak Detection and Repair

The percent reduction in unaccounted water use due to leak detection and repair programs varies with the intensity of the program and the initial conditions of the system. Richards et al. (1984) report reduction as a function of unaccounted water use as:

$$R = 1.33\ (unaccounted/total) \qquad (8)$$

Nonetheless, Richards et al. recommend using the desired percent of unaccounted use as the reduction factor for leak detection and repair. The national average of unaccounted water as a percent of total production is approximately 11.4 percent (AWWA, 1981). The desired percent of unaccounted water use for the reduction factor in the LCC is 10 percent.

Retrofit, Moderate Plumbing Code, and Advanced Plumbing Code

The reduction factors for these measures vary with the water savings generated by the conservation devices installed and the existing level of indoor water use. Again, the formula used is:

$$R = (S/Q_{in}) \qquad (5)$$

where

- R = the fraction reduction of average daily indoor residential use
- S = the water savings resulting from installation of conserving devices, gallons per person per day
- Q_{in} = the average residential indoor water use, gallons per person per day

The values for S and Q_{in} used for the calculation of reduction factors for the LCC are noted in Table II-17 for the respective measures. Note that the value of Q_{in} for the advanced plumbing code is lower than Q_{in} for the moderate plumbing code, thus reflecting the assumption that the advanced plumbing code follows the enactment of the moderate plumbing code.

Coverage Factors

Coverage factors are an indication of the percent of water use within a given sector affected by a given measure at a given point in time. Coverage factors may be approximated by the percent of water users who are in compliance with, or who have adopted, a given measure. The value of the coverage factor may be expected to increase over time as more users comply with a given measure, or decrease as the water-saving devices wear out with time.

Coverage factors are not contained within the library (LCC), rather there are values associated with each measure which are used in conjunction with other data parameters to calculate the coverage factor for a given measure, sector, and year. These values in the LCC are arranged by measure and sector. These values may represent the rates of initial market penetration, adoption, attrition, or demolition depending on the specific measure and sector as shown in Table II-18. Values not shown in Table II-18 are zero. Coverage factor values range from 0.0 and 1.0.

Modification of values in the Library of Conservation Coefficients is possible using a text editor; however, there are two notes regarding modification of values for the calculation of coverage factors. First, the values in the LCC are used in different ways for different measures as shown in Table II-18. The input of a value in a column not used in the calculation of coverage for a given measure will not affect the computation of the coverage factor for that measure. See section 4.4 for a discussion of the structure of the library.

Secondly, coverage factors may be entered in Data Entry screens for each measure and sector specified on screens 15.1 and 15.2 and for each year as specified on the Parameter Control Screen. The option to specify coverage factors is available on screen 17.1, and coverage factors are entered for each year beginning with the base year (screen 17.2). These specified coverage factors are saved in the data file and override the computation of a coverage factor for the specific measure, sector, and year. Thus modification of the values in the LCC for the computation of coverage factors is not necessary. Any coverage factors not specified for selected measures, sectors, and time periods will be calculated using the values in the LCC. This second comment represents the preferred method of modifying coverage factor values.

Coverage factors are calculated in a separate subroutine during the calculation of the water use forecast for each year. The calculation of the coverage factor for a given measure is skipped over if the year of initiation of the measure, as specified on screen 15.1, is greater than the year for which the calculations are being made at that time. The coverage factors used for each year in a forecast run, whether from the screens or calculated from LCC values, are written to the output file .COV. This file may be viewed or printed with any text editor.

Interaction Factors

Interaction factors are used to adjust the effectiveness of conservation measures for any interaction between measures. The method of this adjustment is described at the beginning of this section. The Library of Conservation Coefficients contains an interaction factor value for each possible pairing of the measures listed on screen 15.1 for each of the three water use dimensions (indoor, outdoor, and maximum-day). These values are shown in Tables II-19 through II-21 for the three water use dimensions. Most values are adapted from Richards et al. (1984). A value of 1.0 indicates that there is no interaction, or diminution, of the effectiveness of the two measures being considered. A value of 0.0 indicates that the interaction of the two measures nullifies the effectiveness of the second, or additional, measure; or that the combination of measures is inappropriate for the given dimension. Note that the interaction factors for all combinations of measures which include a user-specified measure have a value of 1.0 and may need to be changed depending upon the definition of the user-specified measure.

Effectiveness of Individual Measures

The conservation routine calculates the adjustment factor (P) for the effect of all applicable measures for a given sector and dimension. This adjustment factor is used to determine the restricted water use for that sector and dimension. In addition, the routine calculates the effectiveness of each individual measure for each sector and dimension. The results of these calculations are written to the conservation output file (.COV) by measure, sector, and dimension for each year. The total effectiveness of measures by sector and dimension is calculated and written to the .COV file for each year along with the total impact of interaction factors on effectiveness by sector and dimension. Finally, the total adjusted effectiveness, that is, total effectiveness minus the impact of the interaction factors, is calculated and written to the .COV file by sector and dimension for each year. The .COV file may be viewed or printed using any text editor. Evaluation of the effectiveness of individual conservation measures is pertinent to the determination of the cost effectiveness of a given measure. See Appendix A for an example of the .COV file.

TABLE II-17

REDUCTION FACTOR VALUES IN THE LIBRARY
OF CONSERVATION COEFFICIENTS

Measure	Dimension[1]	Sector[2]	Value	Source[3]
Public education program	All three dimensions	All, except unaccounted	0.089	Richards et al.
Metering	Indoor	All residential	0.180	Richards et al.
Metering	Outdoor	All residential	0.477	Richards et al.
Metering	Maximum-day	All residential	0.314	Richards et al.
Metering	All three dimensions	Commercial, industrial	0.373	Richards et al.
Pressure reduction	All three dimensions	All, except unaccounted	0.060	Brown and Caldwell
Pricing policy	Indoor, outdoor	Residential	0.020	Boland et al.[4]
Pricing policy	Maximum-day	Residential	0.360	Baumann et al.[5]
Pricing policy	All three dimensions	Commercial	0.277	Boland et al.[4]
Pricing policy	All three dimensions	Industrial	0.232	Boland et al.[4]
Rationing	All three dimensions	All, except unaccounted	0.261	Richards et al.[6]
Sprinkling restrictions	Outdoor	All, except unaccounted	0.221	Richards et al.
Sprinkling restrictions	Maximum-day	All, except unaccounted	0.309	Richards et al.
Industrial reuse/recycling	Indoor, maximum-day	Industrial	0.444	Richards et al.
Commercial reuse/recycling	Indoor, maximum-day	Commercial	0.444	Richards et al.
Leak detection and repair	All three dimensions	Unaccounted	0.100	Richards et al.[7]
Retrofit of showerheads and toilets	Indoor, maximum-day	All residential	0.133	Dziegielewski et al.
Moderate plumbing code	Indoor, maximum-day	Residential metered	0.144	Brown and Caldwell[8]
Moderate plumbing code	Indoor, maximum-day	Residential flat rate, apartment	0.181	Brown and Caldwell[8]
Advanced plumbing code	Indoor, maximum-day	Residential metered	0.225	Brown and Caldwell[9]
Advanced plumbing code	Indoor, maximum-day	Residential flat rate, apartment	0.280	see footnote [10]
Low water-using landscape (new)	Outdoor, maximum-day	Residential metered	0.181	Dziegielewski et al.
Low water-using landscape (new)	Outdoor, maximum-day	Residential flat rate, apartment	0.167	Dziegielewski et al.
Low water-using landscape (retrofit)	Outdoor, maximum-day	Residential metered	0.181	Dziegielewski et al.
Low water-using landscape (retrofit)	Outdoor, maximum-day	Residential flat rate, apartment	0.167	Dziegielewski et al.

TABLE II-17 (Continued)

Notes:

[1] Dimensions are indoor, outdoor, and maximum-day water use.
[2] Sectors are residential metered, residential flat rate (unmetered), residential master-metered apartments, commercial/institutional, industrial, public and other, and unaccounted.
[3] See List of References at end of Part II.
[4] Pricing policy assumes a 50 percent change in price with elasticities sited by source. Recalculation of reduction factors for the pricing measure is strongly recommended for a given application. See text for further explanation.
[5] Reduction in residential maximum-day use is 1.8 times reduction in residential summer use.
[6] A 20 percent reduction goal is assumed; see text for relationship of goal to reduction factor.
[7] Source recommends using desired percent of total production which is unaccounted for as the reduction factor. The value in the LCC assumes the reduction of system losses to 10 percent of total production.
[8] Source reports savings of 13.0 and 16.3 gallons per capita day for single-family and multifamily units, respectively. Reduction factors in the LCC assume 90 gallons per capita day indoor use. See text for further explanation.
[9] Source reports savings of 17.3 gallons per capita day over moderate water-saving devices in single-family units. The reduction factor in the LCC assumes 77 gallons per capita day given moderate plumbing code. See text for further explanation.
[10] No data were reported for multifamily units with advanced plumbing devices. The reduction factor in the LCC assumes the same proportional increase in water use savings between single-family and multifamily units as reported for moderate plumbing codes.

TABLE II-18

VALUES IN THE LIBRARY OF CONSERVATION COEFFICIENTS
FOR THE CALCULATION OF COVERAGE FACTORS

Measure	Sector[1]	Value Label[2]	Value	Use and Assumptions
Public education program	All	Initial	0.750	May vary with the intensity of the program, expresses the percent of total population reached by educational campaigns and events, assumed applicable across all sectors unless the program is designed by the user to target specific sectors.
Metering	All	Initial	0.083	Represents the percent of customers in each sector affected by the installation of meters. Factor of 0.083 represents the nationwide average fraction of unmetered connections as calculated from data provided by AWWA, 1981. Statewide percentages of unmetered connections of the utilities surveyed range from 0.0 for Hawaii to 40 percent for Illinois and New York.
Pressure reduction	All residential	-	-	Pressure reduction values recommended for new service lines only. Coverage values represent the percent of new customers in a sector which are new and is calculated as the increment in number of housing units divided by the total housing units in the current year.
	Commercial Industrial	Initial	0.500	The increment in employment represents not only the increase in new establishments but also the increase in employment in existing establishments. Therefore, the percentage of employment increase due to new establishments in the sector is specified as "initial coverage" and is multiplied by the calculated increment in sector employment. Assumes half of new employment is attributed to new establishments.
Pricing policy	All, except public and unaccounted	Initial	1.000	Represents percent of water users affected by price change with elasticity used in the calculation of reduction factor, assumes full compliance.

TABLE II-18 (Continued)

Measure	Sector[1]	Value Label[2]	Value	Use and Assumptions
Rationing	All, except unaccounted	Initial	0.950	Represents the percent of customers in each sector complying with the emergency rationing requirements, assumes 95 percent compliance.
Sprinkling	All, except unaccounted	Initial	0.750	Varies with the degree of enforcement of the restriction. A value of 0.95 implies a strict enforcement of the regulation with severe penalties or fines imposed. The value 0.75 assumes moderate enforcement.
Industrial reuse/recycling	Industrial	Initial	0.330	Varies with the enforcement of the regulation. Represents the percent of existing industries without water-conserving technologies, and the percent growth of the sector in terms of new industries. Coverage factors of 0.10, 0.33, and 0.60 are suggested for modest, moderate, and maximum levels of programming, respectively. The moderate level value of 0.33 is assumed.
Commercial reuse/recycling	Commercial	Initial	0.330	Same as industrial reuse/recycling.
Leak detection and repair	Unaccounted	Initial	1.000	Assumes full impact of reduction goal as incorporated in reduction factor.
Retrofit	All residential	Attrition Demolition	0.100 0.020	Measure is only applicable to structures not already covered by the installation of water-saving devices; assumes all municipalities have required water-saving devices in new construction as of 1980; thus, the measure is applicable only to structures existing in 1980. The number of housing units existing in 1980 is approximated using the number of housing units in the base year and first forecast year. Assumes installation of devices over a five-year period beginning with the specified year of measure initiation; demolition rate of pre-1980 housing of 2 percent per year; and attrition rate of installed devices of 10 percent per year.

TABLE II-18 (Continued)

Measure	Sector[1]	Value Label[2]	Value	Use and Assumptions
Moderate plumbing code	All residential	Initial	0.950	Varies with enforcement of code, value of 0.95 assumes strict enforcement; coverage factor is calculated as the initial value times the ratio of the cumulative sum of new housing since enactment to total housing for each residential sector.
Advanced plumbing code	All residential	Initial	0.850	Same as for moderate plumbing code; initial value is lower due to higher cost and complex nature of advanced devices.
Low water-using landscapes for new construction	All residential	Adoption	0.250	Coverage factor is adoption rate times the ratio of new units to total housing units.
Low water-using landscapes for existing areas	All residential	Adoption	0.010	Coverage factor is the ratio of homes with newly retrofitted landscapes to total homes, where the number of homes with newly retrofitted landscapes is the adoption rate times the number of homes not already retrofitted with low water-using landscapes.

[1] Sectors are residential metered, residential flat rate (unmetered), residential master-metered apartments, commercial/institutional, industrial, public and other, and unaccounted.

[2] Value labels are initial, adoption, attrition, and demolition rates.

TABLE II-19

INTERACTION FACTOR VALUES IN THE LIBRARY OF CONSERVATION COEFFICIENTS: INDOOR DIMENSION

First Measure	Additional Measure[1] 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Public education programs	0.0	1.0	1.0	1.0	0.180	0.0	1.0	1.0	1.0	0.917	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0
2. Metering	1.0	0.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0
3. Pressure reduction	1.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0
4. Pricing policy	1.0	0.0	1.0	0.0	1.0	0.0	1.0	1.0	1.0	0.900	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0
5. Rationing	0.580	1.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0
6. Sprinkling restrictions	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7. Industrial reuse/recycling	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0
8. Commercial reuse/recycling	1.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0
9. Leak detection and repair	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0
10. Retrofit showerheads & toilets	0.789	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0
11. Moderate plumbing codes	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0
12. Advanced plumbing codes	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0
13. Low water-using landscape (new)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14. Low water-using landscape (existing)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15. User-specified measure 1	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0
16. User-specified measure 2	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	1.0	1.0
17. User-specified measure 3	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	0.0	1.0
18. User-specified measure 4	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	0.0

[1] The effectiveness of the additional measure is multiplied by the interaction factor when the additional measure is used in conjunction with the first measure.

TABLE II-20

INTERACTION FACTOR VALUES IN THE LIBRARY OF CONSERVATION COEFFICIENTS: OUTDOOR DIMENSION

First Measure	Additional Measure[1] 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Public education programs	0.0	1.0	1.0	1.0	0.180	0.952	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.9	1.0	1.0	1.0	1.0
2. Metering	1.0	0.0	1.0	1.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
3. Pressure reduction	1.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
4. Pricing policy	1.0	0.0	1.0	0.0	1.0	0.9	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.9	1.0	1.0	1.0	1.0
5. Rationing	0.580	1.0	1.0	1.0	0.0	0.47	0.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
6. Sprinkling restrictions	0.934	1.0	1.0	1.0	0.55	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
7. Industrial reuse/recycling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8. Commercial reuse/recycling	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9. Leak detection and repair	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
10. Retrofit showerheads & toilets	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11. Moderate plumbing codes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12. Advanced plumbing codes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13. Low water-using landscape (new)	1.0	1.0	1.0	1.0	0.55	0.47	0.0	0.0	1.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0
14. Low water-using landscape (existing)	0.934	1.0	1.0	1.0	0.55	0.47	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	1.0	1.0	1.0	1.0
15. User-specified measure 1	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0
16. User-specified measure 2	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	1.0	1.0
17. User-specified measure 3	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0	1.0
18. User-specified measure 4	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	0.0

[1] The effectiveness of the additional measure is multiplied by the interaction factor when the additional measure is used in conjunction with the first measure.

TABLE II-21

INTERACTION FACTOR VALUES IN THE LIBRARY OF CONSERVATION COEFFICIENTS: MAXIMUM-DAY DIMENSION

First Measure	Additional Measure[1] 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Public education programs	0.0	1.0	1.0	1.0	0.180	0.952	1.0	1.0	1.0	0.917	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0
2. Metering	1.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3. Pressure reduction	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4. Pricing policy	1.0	0.0	1.0	0.0	1.0	0.9	1.0	1.0	1.0	0.900	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0
5. Rationing	0.580	1.0	1.0	1.0	0.0	0.47	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6. Sprinkling restrictions	0.934	1.0	1.0	1.0	0.55	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7. Industrial reuse/recycling	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
8. Commercial reuse/recycling	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
9. Leak detection and repair	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10. Retrofit showerheads & toilets	0.789	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
11. Moderate plumbing codes	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
12. Advanced plumbing codes	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
13. Low water-using landscape (new)	1.0	1.0	1.0	1.0	0.55	0.47	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
14. Low water-using landscape (existing)	0.934	1.0	1.0	1.0	0.55	0.47	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0	1.0	1.0	1.0
15. User-specified measure 1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0	1.0
16. User-specified measure 2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	1.0
17. User-specified measure 3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0
18. User-specified measure 4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0

[1] The effectiveness of the additional measure is multiplied by the interaction factor when the additional measure is used in conjunction with the first measure.

4.4 STRUCTURE OF THE IWR-MAIN LIBRARIES

The IWR-MAIN System uses three library files which contain water use coefficients, conservation coefficients, and climatic variables. The library files are labeled COFLB51, LCC, and FLONLAT, respectively, and may be viewed or edited using a text editor. This section describes the structure of each of these files. Refer to sections 4.1 and 5.3 for modification of the water use coefficients, and section 4.3 for modification of the conservation coefficients.

The Library of Water Use Coefficients (COFLB51 and .WOR)

The library file COFLB51 contains water use coefficients used in the computation of water use estimates for the residential, commercial, industrial, and public/unaccounted sectors used in the output reports. The file also contains category labels for the commercial, industrial, and public/unaccounted sectors. During the Edit/ Validate procedure this file is copied and relabeled as the filename with the extension .WOR. See Part I for an explanation of this procedure. During the Run Model procedure, the .WOR file is read and checked for the proper location of labels and values within the file. The coefficients are then used in the computational routines for each sector.

The first portion of the Library of Water Use Coefficients contains the constant values for the residential demand equations described in Tables II-10 through II-13. These values are listed in the library after the keyword CONSTANT and are arranged by equation identification numbers. The indentification numbers, corresponding equations, and the constant values are shown in Table II-22. The values in the library follow the format shown in Table II-23 after the keyword CONSTANT. See Tables II-10 through II-13 for the equations using these values, and section 5.3 for procedures to follow when modifying these values.

Following the constant values for the residential equations is the keyword CLIMELAS for the climate elasticity data used in the calculation of the weather adjustment factor. The elasticity for the metered and sewered summer moisture deficit should be determined for the specific study area and entered after the label MSSD in order to utilize the weather calibration technique for the metered and sewered western summer equation. The default value of one (1.0) will produce a weather adjustment factor equal to the actual moisture deficit divided by the normal, or long-term average, moisture deficit. See Part II, section 5.3, for a detailed description of the calibration using this elasticity.

The same format is used for the commercial category labels, commercial parameter unit labels, commercial average annual usage coefficients, and the commercial maximum-day usage coefficients as shown in Table II-23. These labels and coefficients follow the keywords COMLABEL, COMMUNIT, COMMAVEG, and COMMAXDY, respectively.

The commercial category labels and corresponding water use coefficients are shown in Table II-14. Note that the average annual and maximum-day usage coefficients are the same, reflecting a lack of information on maximum-day contributions. These coefficients may be changed if data sufficient to justify revised values are available.

The commercial labels and coefficients are followed by the industrial category labels, industrial average annual usage coefficients, and the industrial maximum-day usage coefficients which follow the keywords INDLABEL, INDANAVE, and INDMXDAY, respectively (see Table II-23).

Note that the second column of numbers in the industrial label section is the three- or four-digit SIC code for the category. As with the commercial coefficients, the industrial average annual and maximum-day usage coefficients are the same and may be modified by the user if sufficient supporting data are available. The industrial category labels are shown with the corresponding identification number (Ixxx) and SIC code in Table II-8, and the industrial water use coefficients are shown with the corresponding identification number and SIC code in Table 4-15.

The industrial labels and coefficients are followed by the commercial and industrial price elasticities. The labels CLAS and ILAS identify the commercial and industrial elasticities, respectively.

The nonresidential labels and coefficients are followed by the public and unaccounted average annual water usage coefficients, maximum-day usage coefficients, and category labels. These follow the keywords PUBCOFAA, PUBCOFMD, and PUBLABEL, respectively, as shown in Table II-23. The labels and coefficients for the public and unaccounted sectors are shown in Table II-16. Note that the library file ends with the keyword ENDI.

Through the use of the Data Entry screens, the user may supply additional commercial, industrial, and public categories. The label, parameter unit, and water usage coefficient for each user-added category are merged into the Library of Water Use Coefficients during the Edit/Validate procedure. These user-added categories appear in the .WOR file, never in the COFLB51 file. See the description of the Edit/Validate procedure in Part I for additional explanation of this process.

The Library of Conservation Coefficients (LCC)

The library file LCC contains coefficients used in the computation of the restricted water use estimates. This computation uses reduction factors, coverage factors, interaction factors, and nonresidential indoor/outdoor factors as explained in section 4.3. Reduction factors and coverage factors may be specified by the user via the Data Entry screens for the conservation measures and corresponding water use sectors, which are selected by the user.

Reduction factors not specified by the user for selected measures and sectors are read from the LCC during the Run Model procedure. Similarly, if coverage factors for selected measures and sectors are not provided by the user, values are read from the LCC which are used in conjunction with other parameters (e.g., housing units, employment) to calculate coverage factors for the specified measure and sector. These calculations are explained in Table II-18.

The values for the reduction factors are arranged in the LCC by measure, dimension, and sector as shown in Table II-24. Note that the conservation measure names are abbreviated to five characters and appear in the same sequence as they appear on screen 15.1. The water use dimensions of indoor, outdoor, and maximum-day use are abbreviated to I, O, and MD, respectively. The sectors are abbreviated as follows:

(1) MUNPL -- municipal (this column is not utilized)
(2) RMETR -- residential, metered and sewered
(3) RFLAT -- residential, flat and sewered, and flat and unsewered
(4) RAPMT -- residential, apartment
(5) COMM -- commercial/institutional
(6) IND -- industrial
(7) PUBL -- public and other
(8) UNACC -- unaccounted

Note that the values for the "municipal" sector are not used in the program. All nonzero values for reduction factors are shown in Table II-17.

Values used for the calculation of coverage factors appear in the LCC after the reduction factors. These values are arranged by measure, sector, and rates as shown in Table II-24. The measures and sectors use the same abbreviations as used with the reduction factors. Again, the values for the municipal sector are not utilized. The rates are abbreviated as INITL, ADOPT, ATTRN, and DEMOL for initial, adoption, attrition, and demolition rates, respectively. The nonzero values and their use in the computation of coverage factors are shown in Table II-18.

The values used in the computation of coverage factors are followed by three matrices of interaction factors. There is a matrix of interaction factors for each of the water use dimensions: indoor, outdoor, and maximum-day. Each matrix contains all possible pairings of conservation measures and a corresponding value as shown in Table II-24.

Note that the conservation measures are abbreviated to five characters as used for the reduction factor and coverage calculation values. The interaction factor value for a given pair of measures may be read as the percent effectiveness of the first measure expected when the first measure is used in conjunction with the second measure. For example, EDUCNRATNG 0.580 indicates that only 58 percent of the effectiveness of a water conservation educational program (EDUCN) is expected when a water-rationing program (RATNG) is also in effect. The values for the interaction factors are shown in Tables II-19 through II-21 for the three dimensions, respectively.

Following the matrices of interaction factors are the nonresidential indoor/outdoor factors. These factors are used in the conversion of commercial, industrial, and public water use into the indoor and outdoor water use dimensions in preparation for the application of the calculated adjustment factor for each sector and dimension. This process is described in section 4.3.

As previously described, the user may specify reduction and coverage factors with the Data Entry screens. These user-specified values are saved in the data file which is read during the Run Model procedure prior to the reading of the LCC. Reduction and coverage calculation values will not be read from the LCC file for measures and sectors for which the user has specified a reduction or coverage factor, respectively. Thus, it is not necessary to modify the reduction or coverage calculation values in the LCC. However, there are no Data Entry screens corresponding with the interaction factors or the nonresidential indoor/outdoor factors. Thus, any changes in these values which the user wishes to make should be made in the LCC. It is advised that if changes are to be made, the original LCC file be copied and renamed for archival purposes. The IWR-MAIN System will read the file named LCC.

The Library of Climatic Variables (FLONLAT)

The library file FLONLAT contains long-term averages for rainfall (RAIN) and evapotranspiration (EVAP) for latitude and longitude coordinates in the continental United States. The FLONLAT file is read during the Run Model procedure if values for RAIN and/or EVAP are not provided by the user on Data Entry Screen 1.1, and if the residential metered and sewered sector is selected on the Parameter Control Screen. The data within the library are arranged as follows:

```
EVAPTRAN
LATD 48.  LONG 67.   RAIN 9.        EVAP 12.
LATD 47.  LONG 67    RAIN 8.        EVAP 13.
LATD 46.  LONG 67.   RAIN 7.        EVAP 13.
```

The RAIN and EVAP variables are based on long-term weather data as of 1967 and may not represent shifts in the long-term averages which have occurred in some parts of the country. However, updated long-term averages for these variables may be specified on screen 1.1 for a given study area; thus modification of the FLONLAT file by the user is not necessary.

TABLE II-22

RESIDENTIAL EQUATION CONSTANTS IN THE LIBRARY OF WATER USE COEFFICIENTS

Equation Identification	Equation Number	Usage*	Constant Number	Constant Value
E011	1	Metered and sewered, winter	1	+ 234.000
E012	1		2	+ 1.451
E013	1		3	- 45.900
E014	1		4	- 2.590
E021	2	Flat rate and sewered, winter;	1	+ 28.900
E022	2	and apartment, winter	2	+ 1.576
E023	2		3	+ 33.600
E024	3	Apartment, summer	1	+ 1.433
E041	4	Flat rate and unsewered,	1	+ 30.200
E042	4	winter	2	+ 39.500
E051	5	Metered and sewered,	1	+ 0.480
E052	5	summer west	2	+ 58.777
E053	5		3	- 0.703
E054	5		4	+ 0.429
E061	6	Metered and sewered,	1	+ 385.000
E062	6	summer east	2	+ 2.876
E063	6		3	- 285.800
E064	6		4	- 4.350
E065	6		5	+ 157.770
E071	7	Flat rate and sewered,	1	+ 0.410
E072	7	summer	2	+ 44.573
E073	7		3	+ 0.783
E091	9	Flat rate and unsewered,	1	+ 0.410
E092	9	summer	2	+ 44.573
E093	9		3	+ 0.783
E101	10	Irrigable land per dwelling unit; used	1	+ 0.803
E102	10	in metered and sewered, summer	2	- 1.260
E111	11	Metered and sewered,	1	+2,227.340
E112	11	maximum-day west	2	+ 2.060
E113	11		3	+ 0.4130
E121	12	Metered and sewered,	1	+ 0.000046485
E122	12	maximum-day east	2	+ 0.118
E123	12		3	- 10.400
E124	12		4	- 1.250
E125	12		5	+ 0.931

TABLE II-22 (Continued)

Equation Identification	Equation Number	Usage*	Constant Number	Constant Value
E131	13	Flat rate and sewered,	1	+1,609.590
E132	13	maximum-day	2	+ 0.943
E133	13		3	+ 0.523
E151	15	Flat rate and unsewered,	1	+1,609.590
E152	15	maximum-day	2	+ 0.943
E153	15		3	+ 0.523

*See Tables II-10 through II-13 for corresponding equations.

TABLE II-23

FORMAT OF THE LIBRARY OF WATER USE COEFFICIENTS

```
CONSTANT
E011 234.0                E012 1.451                E013 -45.9
E014 -2.59                E021 28.9                 E022 1.576
E023 33.6                 E041 30.2                 E042 39.5
.
.
.
ENDD
CLIMELAS (EI ASTICITIES FOR WEATHER ADJUSTMENT FACTORS)
MSSD 1.0
ENDD
COOMLABEL
C001 MIS. COMMERCIAL      COO2 VOC. SCHOOLS         C003 MISC. RETAIL
C004 BOARDING HOUSES      C005 TRANSP. TERMINAL     C006 BARBER, CLEANING
.
.
.
ENDD
COMMUNIT
C001 EMPLOYEES            C002 EMPLOYEES            C003 EMPLOYEES
C004 EMPLOYEES            C005 EMPLOYEES            C006 EMPLOYEES
.
.
.
ENDD
COMMAVEG                  EXPECTED USAGE VALUES
C001 47.2                 C002 72.0                 C003 19.3
C004 101.6                C005 86.2                 C006 380.2
.
.
.
ENDD
COMMAXDY                  EXPECTED USAGE VALUES
C001 47.2                 C002 72.0                 C003 19.3
C004 101.6                C005 86.2                 C006 380.2
.
.
.
ENDD


INDLABEL
I001 201  MEAT PRODUCTS          I001 2011 MEAT PACKING PLANTS
I003 2013 SAUSAGES, ETC.         I004 2016 POULTRY DRESSING
I005 2017 POULTRY & EGG DRSG     I006 202  DAIRY PRODUCTS
.
.
.
ENDD
```

TABLE II-23 (Continued)

```
INDANAVE
I001 343.8                  I002 258.6                  I003 488.1
I004 409.1                  I005 201.1                  I006 354.4
.
.
.
ENDD
INDMXDAY
I001 343.8                  I002 258.6                  I003 488.1
I004 409.1                  I005 201.1                  I006 354.4
.
.
.
ENDD
ELASTCTY (COMMERCIAL AND INDUSTRIAL PRICE ELASTICITY)
CLAS -0.80                  ILAS -0.65
ENDD
PUBCOFAA
LOSS 14.9                   FSER 5.2                    FLSS 0.15
END
PUBCOFMD
LOSS 14.9                   FSER 5.2                    FLSS 0.15
ENDD
PUBLABEL
LOSS LOSS (PER CAP.)        FSER FREE SERVICE           FLSS LOSS (PERCENT)
ENDD
ENDI
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TABLE II-24

FORMAT OF THE LIBRARY OF CONSERVATION COEFFICIENTS

REDUCTION FACTORS

MEASURE	MUNPL	RMETR	RFLAT	RAPMT	COMM	IND	PUBL	UNACC
EDUCN-I	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.0
EDUCN-O	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.0
EDUCN-MD	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.0

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COVERAGE FACTORS

MEASURE	INITL	ADOPT	ATTRN	DEMOL
EDUCNMUNPL	0.750	0.0	0.0	0.0
EDUCNRMETR	0.750	0.0	0.0	0.0
EDUCNRFLAT	0.750	0.0	0.0	0.0
EDUCNRAPMT	0.750	0.0	0.0	0.0
EDUCNCOMM	0.750	0.0	0.0	0.0
EDUCNIND	0.750	0.0	0.0	0.0
EDUCNPUBL	0.750	0.0	0.0	0.0
EDUCNUNACC	0.750	0.0	0.0	0.0

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INTERACTION FACTOR MATRIX (IFACT)

INDOOR

EDUCNEDUCN	0.000	EDUCNMETER	1.000	EDUCNPRESS	1.000	EDUCNPRICE	1.000
EDUCNRATNG	0.580	EDUCNSPRNG	0.000	EDUCNINDRR	1.000	EDUCNCOMRR	1.000
EDUCNLEAKR	1.000	EDUCNRETRO	0.789	EDUCNCODEM	1.000	EDUCNCODEA	1.000
EDUCNLWULN	0.000	EDUCNLWULR	0.000	EDUCNMSEO1	1.000	EDUCNMSE02	1.000
EDUCNMSE03	1.000	EDUCNMSE04	1.000				

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NONRESIDENTIAL INDOOR/OUTDOOR FACTORS

COMMERCIAL	0.800
INDUSTRIAL	0.800
PUBLIC	0.800

5. MODEL VERIFICATION AND CALIBRATION

5.1 PURPOSE OF VERIFICATION AND CALIBRATION

Verification and calibration of the IWR-MAIN System are usually undertaken to verify and/or improve the accuracy of water use equations in reproducing the actual water use by various sectors of the municipal system under study. The precision with which IWR-MAIN estimates water use can be tested by preparing a forecast of water use for one or more historical years. A comparison of IWR-MAIN estimates with actual records of water use may reveal discrepancies which need to be analyzed and corrected prior to performing the forecasts.

In most recent applications of IWR-MAIN, the calibration forecasts were typically prepared for the base year of 1980 and one forecast year of 1985. The availability and quality of socioeconomic data and the values of other determinants of water use for these two years are good, since they represent, respectively, the year of the Census and the year of Census estimates.

Reasons for Forecast Discrepancies

There are several reasons why the unadjusted estimates of water use produced by IWR-MAIN may diverge from observed values. These are:

(1) The socioeconomic data for the forecast year (and/or base year) may be in error. A substantial margin of error can be expected even in the Census data for the Census year, with a larger error associated with intermediate years. In addition, geographical areas served by water utilities rarely coincide with political subdivisions or Census tracts for which socioeconomic data are collected. This may lead to imprecise estimates of population, housing units, employment, and other data which correspond to the water service area.

(2) Water use records may include a substantial error especially when a large number of individual accounts are aggregated by computer to arrive at total water sales, or when meter-reading cycles do not coincide with calendar dates. When water production records are used in the comparison, the potential for error is usually smaller, although problems with uncalibrated master-meters at water treatment plants have been experienced by some systems.

(3) There are discrepancies in definitions of water users and water use dimensions between IWR-MAIN and utility records. For example, winter use is defined by IWR-MAIN as domestic (or indoor use) in an average day. Many utilities define winter use as average daily use during winter months (e.g., November to April or December to February).

(4) IWR-MAIN estimates water use for average weather conditions; therefore, it is necessary to make weather adjustments while attempting to reproduce water use in a particular calendar year. For example, the year 1980 can be extremely wet and cool (i.e., with low summer moisture deficit), indicating low water use, while 1985 may be dry and hot, indicating higher water requirements.

(5) The residential water demand equations have been developed based on prevailing patterns of water use during the mid-1960s. Few communities practiced water conservation at that time, and the unrestricted IWR-MAIN results do not account for the effects of conservation measures. These effects have to be estimated based on documented water savings and market penetration of each measure for each calibration year and subtracted from the unrestricted demand forecast before the IWR-MAIN estimates can be compared with actual records.

(6) In some areas of the country, homeowners plant winter grass and practice winter irrigation. Such a practice was not common in the mid-1960s when the original IWR-MAIN equations were

developed. The IWR-MAIN seasonal use equations have to be modified for such areas to reflect the winter irrigation use.

(7) The relationships between water use and its determinants may not be applicable to a given locality or may have changed since the mid-1960s. Elasticities of price, income (i.e., home value), moisture deficit, and the number of people per residence may be inappropriate for some locations. These have to be verified if the prediction error is substantial.

(8) Water use for nonresidential sectors is estimated by IWR-MAIN based on unit use coefficients (daily use per employee or other parameter unit) derived from nationwide data. These coefficients may not reflect local rates of water use and have to be adjusted using local information.

(9) The values of residential homes in some areas of the country include a substantial location premium which has little bearing on water use, except for measuring the ability of the residents to pay for water. If home value is taken to represent the stock of water-using fixtures, appliances, and architectural features of the residential landscape, then a four-bedroom single-family house with a replacement value of $75,000 is expected to have similar capital water-using stock regardless of its location. The presence of a substantial location premium will bias the estimates of water use.

Some of these factors can be incorporated into IWR-MAIN forecasts on an a priori basis (e.g., actual weather conditions, water conservation, winter irrigation, and adjustment of home values may be performed prior to generating the forecast estimates), while other factors such as elasticities of water use determinants have to be tested and adjusted, if necessary, based on relationships observed in the study area. The following sections describe the data required and the procedures that may be used to verify and calibrate the IWR-MAIN model to the conditions of a particular study area.

5.2 VERIFICATION DATA

Water Use Records

Ideally, the data for verifying the IWR-MAIN estimates of water use derived from socioeconomic data describing a service area during calibration years should be comprised of detailed records of water use by all user sectors and all use dimensions selected in the preparation of an IWR-MAIN forecast. However, in most applications, the availability of water use records will be limited. Some larger utilities will maintain monthly water use records for several aggregate categories of users such as single-family residential units, small commercial users, large industrial users, and others. However, many utilities will not generate and maintain water use statistics by user sectors. Thus, only aggregate monthly sales may be available. Finally, if water customers are not individually metered, the verification has to be limited to the use of aggregate production records, although again there are few utilities in the country which do not have meters at water treatment plants. In such extreme situations verification and calibration of the IWR-MAIN model are not possible except for a rough comparison of IWR-MAIN estimates with estimated water withdrawals from supply sources.

Typically, water utilities will maintain computer records of monthly water consumption for all individual customers. The length of record may be 12 months (or 12 billing periods) or more with earlier records stored on computer tapes or microfiche. Each customer's file may contain account number, name, address, meter size, meter readings and dates, consumption (or water use), and amount billed. If individual customer files contain codes identifying the type of customer, then a computer program may be prepared to produce summaries by customer type.

Without the identification of customer types, an approximate separation of users by residential and nonresidential categories can be performed based on the connection size with a manual classification of the largest users. Alternately, a random sample of customer accounts may be taken in order to obtain the percentage of total water use and average customer use for each major user sector (i.e., residential, commercial, industrial, public, and others).

Supplemental Data

In addition to water use records, verification of IWR-MAIN requires the following types of information:

(1) Prevailing weather conditions (temperature and precipitation) during calibration years
(2) Water and sewer rates in effect prior to and during the calibration years
(3) Water use and employment in selected commercial establishments and manufacturing plants served by the utility
(4) Information on past and current water conservation programs (i.e., the estimated water savings and market penetration of conservation measures)

Additional data may be required in cases where the discrepancies between IWR-MAIN estimates and actual water use records warrant additional adjustments in the predictive equations or estimating procedures of IWR-MAIN.

5.3 VERIFICATION AND CALIBRATION PROCEDURE

The process of the verification and calibration of IWR-MAIN is comprised of four major steps. These are given below.

Step 1 -- Initial Forecast Run

As a basis for verification and initial adjustments, a forecast for a base year and one or more projection years should be prepared with all default parameters of IWR-MAIN. Since IWR-MAIN is designed for long-term forecasting, it would be most appropriate to use as an example the year 1970 as the base year and 1975, 1980, and 1985 as forecast years. A complete set of socioeconomic data (i.e., population, housing, employment, and income) should be assembled for each year and entered as an input file. The results of the forecast should be compared with actual water use records in order to obtain a crude assessment of the accuracy of IWR-MAIN. The results will reveal the particular sectors of water use that may need to be further investigated. However, the discrepancies between forecast results and actual water use records may not be representative of the forecast error, since this initial run does not incorporate a number of factors that will affect water use estimates (e.g., actual weather, price levels, conservation programs, and others).

Step 2 -- A Priori Adjustments Run

In this step, a set of adjustments to IWR-MAIN is performed on the basis of prior knowledge of differences between the implicit assumptions of the model and actual conditions of the forecast. There are four types of adjustments that are made on the basis of prior knowledge. These are discussed below.

Substep 1. Weather Adjustments

In order to compare water use records with IWR-MAIN estimates, sprinkling and summer demand equations must be adjusted to reflect actual weather conditions. Only the equations for the metered and sewered residential subgroup utilize weather variables. The eastern and western equations for this subgroup are handled differently, as shown below. A procedure is also described which may be applied to the summer water use equations for the other residential subgroups. The two equations from Table II-10 for summer (seasonal plus domestic) demand in metered and sewered residential houses are:

$$(Q_s)_{ms,e} = 385.0 + 2.876V - 285.8P_s - 4.35I_s + 155.77\ (B*MD) \quad (1)$$

and

$$(Q_s)_{ms,w} = (2 * 0.48 * 58.777P_s^{-0.703} * V^{0.429}) * WF + (Q_d)_{ms} \quad (2)$$

where

$(Q_s)_{ms,e}$ and $(Q_s)_{ms,w}$ represent metered and sewered summer water use in eastern and western areas of the country, respectively, in gallons per unit per day

and

P_s = summer price of water (including sewer charges if applicable)
V = market value of the residence in 1980 dollars
I_s = summer bill difference, in 1980 dollars
B = irrigated lot area in acres
MD = summer moisture deficit (during June, July, and August)
WF = weather adjustment factor
Q_d = domestic (indoor) water use in gallons per unit per day

The value of B is calculated as:

$$B = 0.803\, H_{DENS}^{-1.26} \quad (3)$$

where

H_{DENS} = housing density in housing units per acre

and the value of WF is calculated as:

$$WF = (MD_{actual}/MD)^{md}$$

where

MD_{actual} = actual summer moisture deficit for a specific calibration year
md = elasticity of water use with respect to moisture deficit

In order to account for the influence of weather in the base year or a forecast year for the eastern U.S., the MD variable in equation (1) should reflect the actual weather conditions in the year of verification. Note that the demarcation of east and west by IWR-MAIN is 100 degrees longitude. Actual summer evapotranspiration and precipitation can be entered in the data input screen 1.1. If actual weather factors are not used, MD in equation (1) is represented by the normal moisture deficit as calculated from normal values or those read from the IWR-MAIN Library of Climatic Variables.

For western areas, the summer demand equation (2) consists of a summer sprinkling term plus the domestic water use. To account for the influence of weather in the base year or a forecast year, the sprinkling term is adjusted by the weather adjustment factor (WF) which is a ratio of the actual to normal summer moisture deficits. (Future years assume normal weather, thus the weather adjustment factor would have a value of one (1).)

In the present version of IWR-MAIN, only one set of weather parameters can be used during the run of the model. To generate weather-adjusted estimates for the base year and forecast years, the actual weather data must be changed and model runs must be performed for each year. Once the final verification runs have been completed (see Step 3), the actual weather data should be deleted before generating forecasts. Forecast runs should assume normal weather conditions.

The elasticity for the weather adjustment factor is read from the Library of Water Use Coefficients and may be revised by the user to reflect the elasticity of metered and sewered summer water use to moisture deficit. The default value of 1.0 results in a weather adjustment factor equal to the ratio of the actual and normal moisture deficits.

To introduce the weather adjustment factor into the equations for flat-rate and sewered or flat-rate and unsewered water use, the weather adjustment factor is multiplied by the intercept of the sprinkling term (0.41), and the product replaces the value of the intercept in the Library of Water Use Coefficients. See section 4.4 for a description of the library format and Table II-22 for the identification code (E071 and E091) of these intercepts. This same procedure may be used to account for the influence of weather in apartment summer use by multiplying the sprinkling multiplier (1.433) by the weather adjustment factor and replacing the multiplier value (E024) in the library with the product. These adjusted intercepts will have to be changed in the library for the base year and each forecast year used for verification, and corresponding model runs must be performed each time.

Substep 2. Adjustments for Winter Irrigation

In some urban areas of the country located in the South (Florida) and Southwest (Texas, New Mexico, Arizona, Nevada, California), residential lawns are overseeded with winter grass and irrigated during winter months. The IWR-MAIN System equations for winter water use are designed to measure only indoor water use. Sprinkling demand and other outdoor uses are accounted for in summer equations; however, the original demand models were estimated based on data collected during the early 1960s when winter irrigation was not practiced extensively.

Prior to making adjustments for winter irrigation in residential equations, it is necessary to investigate the monthly distribution of annual water use to determine the portion of irrigation water use which occurs during winter months. As a rule of thumb, in cities where winter irrigation is practiced, the irrigation requirements may constitute 10 to 20 percent of annual outdoor use. The estimates of water use in summer should be increased by this percentage to account for winter irrigation. For western areas, the intercept of the sprinkling term (see description above) can be divided by the percent of summer outdoor use. IWR-MAIN estimates of winter water use will be lower than actual water use records, given that the winter equations only represent indoor (domestic) use.

Substep 3. Adjustment for Existing Conservation

Since the 1975-76 California drought, many municipalities in California and other states have adopted long-term (or nonemergency) conservation programs. These programs often include educational campaigns, revised plumbing codes for new construction, leak detection and repair, conservation-oriented rate reforms, and other activities. The existence of these programs is reflected in the observed levels of water use. Therefore, the IWR-MAIN estimates must be adjusted for the effectiveness of all conservation measures that have been implemented. In practice, the comparisons should be made between water use records and the restricted use estimates of IWR-MAIN. Reduction factor and coverage factor coefficients should be obtained for each measure. If there are no data available on these parameters, IWR-MAIN library values could be used, although the local estimates are clearly preferred for calibration runs.

Substep 4. Adjustment of Nonresidential Water Use Rates

The initial forecast run (Step 1) will reveal the need to verify the IWR-MAIN default coefficients for per employee water use in various commercial and manufacturing categories. Per employee use rates should be verified for the largest utility customers by dividing their average annual water use by the number of employees. Ideally, a sample of nonresidential customers (including the largest users) should be taken with a size sufficient to verify all per employee coefficients used in the forecast. Due to difficulties involved in obtaining employment

data, a point will be reached where obtaining additional observations on water use and employment can no longer be justified. The coefficients most critical for the forecast are those representing commercial and manufacturing categories which have high employment or show high projected growth of employment and those which are large-quantity users.

If the default coefficients in the library are replaced with revised coefficients and if the nonresidential price difference adjustments are used, it may be necessary to revise the commercial or industrial average price in the year concurrent with the water use coefficients in the input data (screen 7.7).

Step 3 – Detailed Verification Run

Upon completion of the a priori adjustments in Step 2, the IWR-MAIN runs should be performed. The resulting estimates of water use for the base year and all calibration years should be compared with actual values to determine whether the IWR-MAIN water use models need to be adjusted. The computational equations for the residential subgroups may require calibration if the estimates of water use obtained with IWR-MAIN differ from actual use by more than 2 to 3 percent. The type of adjustments that will be required will depend on the pattern of prediction errors. At least two distinct patterns may be present.

(1) The IWR-MAIN estimates exhibit a systematic error of overpredicting (or underpredicting) actual water use in all calibration years (including the base year) where the percent error is approximately the same for all years. This pattern of prediction error indicates that water use in the study area is characterized by a higher (or lower) base use than that observed in the data which were used to derive the IWR-MAIN demand models.

(2) The IWR-MAIN estimates do not exhibit a systematic error, that is, water use is underestimated in some years and overestimated in others. This type of error indicates that the slopes (or elasticities) of basic determinants of water use in demand equations are in error. These determinants include combinations of variables including price, income, moisture deficit, and population density per residence.

In the case of the first type of error, the calibration procedure involves adjusting the intercepts of appropriate demand models to fit the observed water use. The calculation of the adjusted intercepts in linear demand models is illustrated in the following example:

Actual indoor (winter) use	10.365 MGD
IWR-MAIN estimate	12.209 MGD
Number of metered and sewered housing units	41,561 units
Original IWR-MAIN intercept	234 gallons per unit per day

Required adjustment:

$(10.365 - 12.209)(10^6)/41{,}561 = -44.4$ gallons per unit per day

New intercept $234 - 44.4 = 189.6$ gallons per unit per day

In multiplicative models such as those used for estimating summer use in western areas of the country, the intercepts are adjusted by a constant multiplier derived by comparing actual and predicted water use, as illustrated in the following example:

Actual indoor (winter) use	10.365 MGD
Actual indoor and outdoor (summer) use	26.653 MGD
IWR-MAIN estimate of summer use	29.250 MGD
Original IWR-MAIN sprinkling intercept	0.480

Required adjustment (assuming prior adjustment of the intercept in winter equation):

(26.653 - 10.365)/(29.250 - 10.365) = 0.86

New intercept 0.48 x 0.86 = 0.410

In the case of the second type of error, the intercepts may be adjusted to achieve an improved fit of the model to actual water use for all calibration years; however, at some point this adjustment procedure will lead to reduced errors in some years at the expense of increased errors in others. To bring the IWR-MAIN estimates closer to actual values, it will be necessary to modify the coefficients of individual independent variables in the demand models. The variables which are likely to have inappropriate coefficients include price and income. The error in IWR-MAIN estimates provides very limited possibilities for verifying elasticities of these variables, since only their combined effect can be observed. A preferred procedure in such cases is to reestimate the demand models in question using 20 to 30 data points on annual (or seasonal) water use in the study area. Although time-series data are preferred, cross-sectional or pooled data sets can be generated if there is more than one utility.

In many previous applications of IWR-MAIN, the water demand models performed relatively well, and there was no need to reestimate the coefficients of price, income, and population density. The elasticity of the moisture deficit was usually verified based on a small sample of water use records. Elasticities of price, income, and population density seem to show little variation within each of the two climatic zones of the country: arid west and humid east.

Step 4 – Verification of Growth Models

In IWR-MAIN applications which rely on internal growth models, separate runs can be performed in order to verify the econometric equations which allocate total housing units and employment to various forecast categories based on income, population, and other economic growth factors. Internally projected values for past years may be compared to actual data from the study area while values projected for future years may be compared to any existing projections for the area. Direct external projections supplied by the user replace parameters generated by the growth models. Thus, total housing units, housing units for a given subgroup and market value group, employment for a given commercial category, and/or employment for a given industrial category may be specified for each forecast year. (See the description of screen 14.1 in Part I and the discussion of the external projections in Part II, section 4.2.) If data for these parameters are available, the external projection can be entered for the forecast years. Note that external projections for one forecast year have no impact on projections generated by the growth models for other forecast years. Additional runs may be executed to observe the impact of the external projections on the redistribution of values generated by the internal growth models.

Similarly, historical data for the study area may be entered into the program, runs made, and the impact of the historical trends on the projections can be compared to existing projections. In this manner, a projection method or combination of methods may be selected which generates a set of projected values most appropriate for the given study area.

APPENDIX A

COMPREHENSIVE EXAMPLE OF USING THE IWR-MAIN SYSTEM

Exhibit A-1: **Input Screens**

Exhibit A-2. **Revised Coefficient Library (.WOR) File**

Exhibit A-3: **Output Reports**

Exhibit A-4: **Conservation Output (.COV) File**

COMPREHENSIVE EXAMPLE OF USING THE IWR-MAIN SYSTEM

For illustrative purposes, a comprehensive example using the IWR-MAIN System was performed using empirical data from a southwestern U.S. city. Unlike TESTCITY, this example is a complete and actual forecast using the best available data and information for the study area. The water use estimation was completed for the base year (1980) and two forecast years (1990 and 2000).

STUDY AREA

Aridwest is a large southwestern city with a 1980 population of 425,259. This population represents over 88 percent of the total county population. Aridwest's steady growth is projected to continue. The city has a substantial industrial base with over 35,800 employed in manufacturing for the year 1980.

The study area experiences typical southwestern climatic conditions. Mean summer temperatures range from 80 to 83 degrees Fahrenheit. The mean annual precipitation is about eight inches. Mean winter temperatures rarely fall below 45 degrees Fahrenheit.

SOCIOECONOMIC INPUT DATA

General Municipal Data

The required base year population and total employment for the study area were obtained from U.S. Census Reports. The median household income for the base year was provided by local city data sources. Total summer season (June-August) precipitation and summer potential evapotranspiration were calculated for Aridwest using monthly temperature and rainfall data provided by the National Oceanic and Atmospheric Administration (NOAA). Projections for the years 1990 and 2000 of population, household income, and total employment were supplied by the city planning department.

Residential Data

Housing Stock Data

The housing stock data provided by the city were classified into three housing types in order to facilitate a more accurate estimation of water use. Each housing type represents a major subgroup in the IWR-MAIN System and is described below.

(1) The metered and sewered housing subgroup includes single-family residential units that are individually metered and are served by a sewer system. These housing units are considered owner-occupied or occupied by renters who are responsible for paying the water bill. All single-family subgroups were grouped into the metered and sewered category. The number of "other" (nonsewer) single-family units was relatively small and was thus included in the metered and sewered category.

(2) The flat rate and sewered category includes housing units contained in buildings with two or three units per structure and mobile home parks. It is assumed these units are served by a single meter

and that where renter-occupied, the owner is responsible for paying the water bill. Such customers, therefore, face a zero marginal price and are not expected to react to price. All sewered mobile homes and two-family units were aggregated as flat rate and sewered.

(3) The apartment category refers to housing units which face a zero marginal price of water and have little opportunity to engage in outdoor (seasonal) water uses. This includes master-metered apartments, represented by housing units contained in structures with three or more units. It is assumed that all these units are provided with sewer services.

The market value of a residence is used by IWR-MAIN as one of the major determinants of water use. The reported home values for single-family residences are available from census reports. For multifamily dwellings, the contract rent of a renter-occupied unit was converted to equivalent home values using the following formula:

$$F = \frac{(1 + i)^N - 1}{i(1 + i)^N} \qquad (1)$$

where

F = a series present worth discounting factor
i = typical 1980 mortage rate in Aridwest = 1.167 percent per month (14.00 percent per year)
N = 360 months

The product of the monthly rent and the conversion factor, F, is the estimated home value in 1980 dollars.

Supplemental Data for Housing Subgroups

In addition to the distribution of housing units by home value ranges, each subgroup requires supplemental data that are used in the computation of water use estimates. Used only in the metered and sewered category, the price variables (marginal price and bill difference) were calculated by applying the 1980 Aridwest Water Utility (AWU) water and sewer price schedules to average monthly usage per single-family account. The marginal price of water/sewer is the price paid for the last unit of water consumed. The bill difference variable captures the effects of changes in consumers' residual income caused by increased or decreased water bills as a result of changes in rate designs and is calculated as the difference between the actual total water bill and the product of the quantity consumed and the effective marginal price.

The price estimates were initially assumed to be constant across all housing value ranges. Using preliminary IWR-MAIN output reports, the appropriate price blocks for each value range in the subgroups were determined by calculating average usage per account in the winter season and average usage per account in the summer season. This procedure indicated that water use in higher value homes shifted the average user into the second price block. Whenever the marginal price variables indicated a shift to the second block, the corresponding bill difference variables were also adjusted.

The number of persons per household is a water use parameter in the flat rate and sewered and the apartment categories. This information was obtained for owner- and renter-occupied housing units by value range in the Aridwest Standard Metropolitan Statistical Area (SMSA).

Projections of total housing units and housing units by type were provided by the city planning department.

Commercial and Industrial Data

Base Year

The commercial/institutional employment data for the base year were obtained from the U.S. Census Report. This employment was then disaggregated into 23 IWR-MAIN commercial/institutional categories, each representing a combination of Standard Industrial Classification (SIC) codes (see Part II, Table II-6).

Base year employment data for manufacturing (industrial) were also provided by the U.S. Census. These data were distributed by SIC codes and assigned to a possible 198 IWR-MAIN industrial categories (see Part II, Table II-8).

Projections

Sector employment projections (i.e., manufacturing, construction, services, government) for the years 1990 and 2000 were obtained and entered directly into IWR-MAIN. Distribution of sector employment into commercial and industrial categories is performed by the internal growth models of IWR-MAIN. External projections for six industrial categories served as upper bounds for the growth models. These external projections were based on a water resources report for the state in which Aridwest is located. The report states that 90 percent of industrial water use at the state level is attributed to four industries in SIC groups 20, 26, 28, and 33. Growth rates provided by the report were applied to the actual 1980 Aridwest industrial employment.

Public/Unaccounted Data

Historical water production and usage data from the Aridwest Water Utility (AWU) indicate an average annual loss of 11 percent of the total metered use.

CONSERVATION INPUT DATA

Aridwest is very active in water conservation and in 1980 had four major conservation programs which were already reducing water usage in the AWU service area. These conservation measures include amendment of plumbing codes, promotion of desert landscaping, water conservation educational programs, and leak detection and repair. It is anticipated that these existing water conservation measures will continue to reduce water usage. The following is a brief description of each measure and an example of how reduction factors were calculated for these measures.

Plumbing Code

Amendments to the city plumbing codes in 1977 required that all new and replacement toilets be designed to use no more than four gallons of water for a flush cycle. Furthermore, all new and replacement showers were to be equipped with a flow control device that limits water flow from the head to a maximum three gallons per minute at 50 pounds per square inch pressure.

The fraction reduction of water use (R) is calculated as:

$$R = (S_d/Q_{in}) \qquad (2)$$

where

R = fraction of average daily residential use
S_d = water savings resulting from installation of a conserving device, gallons per person per day
Q_{in} = average indoor water use, gallons per person per day

Expected water savings from installation of water-conserving toilets and low-flow showerheads are reported as 13.0 gallons per person per day for single-family residences and 16.3 gallons per person per day for multifamily residences. The reduction factor for the plumbing code is calculated based on equation (2) as:

$R_{single\text{-}family} = (13.0/164) = 0.079$
$R_{duplex\text{-}triplex} = (16.3/107) = 0.152$
$R_{apartment} = (16.3/107) = 0.152$

The fraction of average daily (annual) consumption that would be affected by the enforcement of the revised plumbing code is the number of new homes that would comply with the code, less 5 percent for exemptions of the special-purpose showerheads specified in the plumbing code, plus the number of remodeled units complying with the codes. Assuming that the number of remodeled units equals 5 percent of the number of new units, the coverage factor can be determined as the ratio of new units to total units.

Desert Landscaping

In 1971 a landscaping program was adopted by the utility to promote desert landscaping through an annual contest. The fraction reduction of water use resulting from the conversion of turf area to low water-using arid landscape is calculated as:

$$R = (a)\,(b)\,(c)\,(d) \qquad (3)$$

where

R = fraction reduction of average daily residential use
a = percent area converted to desert landscape
b = percent reduction in the water application rate
c = percent irrigation of outdoor use
d = percent outdoor use of annual use

The portion of turf area converted to desert landscaping is assumed at 30 percent. The percent reduction in irrigation use as a result of converting to low water-using plants is calculated from the difference in application rates. The water use ranges of plants in desert climates are:

Low water-requiring plants	10-20 inches per year
Medium water-requiring plants	20-35 inches per year
High water-requiring plants	35-50 inches per year

See Water Conservation for Domestic Users, with Special Reference to Warm Desert Climates, a handbook prepared by the University of Arizona for the city of Tucson, 1977. The average application rate for turf areas is estimated to be 42 inches per year, the midpoint of the high water-use range, while the application rate for desert landscaping is estimated to be 20 inches per year. Thus, the reduction in irrigation use is approximately 50 percent. The portion of outdoor water usage attributed to irrigation is assumed at 80 percent of outdoor water use.

The fraction reduction of residential water use for single-family, duplex-triplex, and apartments is calculated as:

R_{SF}	= (.30) (.50) (.80) (.43)	= 0.052
R_{D-T}	= (.30) (.50) (.80) (.27)	= 0.032
R_{Apart}	= (.30) (.50) (.80) (.19)	= 0.023

The coverage of the voluntary desert landscaping program was reported as being 18 percent of single-family residences in 1985 with an expected increase of 1 percent of all housing units per year. Given that the program began in 1971, coverage for 1980 was extrapolated to 11.6 percent of 1980 single-family housing.

Education Programs

Water conservation education programs pursued by AWU include the "stuffers," or literature enclosed with water bills, distribution of the booklet Water Conservation in Your Home, an outreach program of lectures and films presented to schools and civic groups, and an outreach specialist who provides written material to local newspapers.

Reduction factors for school educational programs vary from .035 to .05 in California and vary nationwide from .023 to .092. A reduction value of 0.035 was assumed as representative of the educational programs conducted by AWU. The coverage factor is assumed as 0.95 percent due to the high intensity of the educational campaign. The residential water use is assumed as the major sector targeted by the education programs.

Leak Detection and Repair

Since 1966, AWU has operated a leak detection and repair program in which six to eight miles of pipeline have been either repaired or replaced every year. The effect of this program has been a reduction of water losses to approximately 10 percent of total production or 11 percent of metered use. Continuation of this program is expected to further reduce water losses. It is assumed that if the current program is maintained at the current level for the next 15 years, the percent of water unaccounted for will decrease from the current 11 percent of metered use to 9 percent in 1990, 8 percent in 1995, and remain at the 8 percent level thereafter.

VERIFICATION AND CALIBRATION PROCEDURES

Verification and calibration of the IWR-MAIN System are usually undertaken to verify and/or improve the accuracy of water use equations in reproducing the actual water use by various sectors of the municipal system under study. Typically, the procedure is conducted in two steps. First, the coefficients of computational equations and the national water use coefficients contained in the system's library are verified using the information on local conditions. Second, the coefficients of relevant independent variables of computational equations may be further tested by preparing a short-term forecast for a year with known actual water use. After testing, the revised coefficients are entered in the library and are used in estimating water use in future years.

The most recent year for which all socioeconomic and other determinants of water use are available is 1980, the year of the last available U.S. Census of Population and Housing. The 1980 Census data, the Aridwest 1985 socioeconomic projections, and NOAA weather data were used to prepare preliminary water use forecasts for 1980 and 1985. The procedures used in verifying and calibrating the IWR-MAIN System are discussed below.

Adjustments of Residential Demand Models

The demand equations for each residential subgroup are presented below with a discussion of the verification and calibration of the individual predictive equations.

Metered and Sewered Models

The winter (or indoor) demand for water by metered residences is estimated by IWR-MAIN using the following equation:

$$(Q_d)_{ms} = 234.0 + 1.451V - 45.9P_a - 25.9I_a \quad (4)$$

where

$(Q_d)_{ms}$ = water use in gallons per dwelling unit per day
V = home value in $1,000
P_a = marginal price of water (including sewer charges) in winter in dollars per 1,000 gallons
I_a = effective bill difference variable during the winter in season dollars

The price elasticity of water demand at the mean values of price and water use in the above equation is -0.20 when the effects of disposable income that are captured by the bill difference are ignored and -0.06 when such effects are taken into account. The elasticity of home value (a proxy for income) is 0.22.

The equation for summer demand used by IWR-MAIN is:

$$(Q_s)_{ms} = (0.48 * 58.77 * P_s^{-0.703} * V^{0.429}) * (MD_i/MD_n)^e * 2.0 + (Q_d)_{ms} \quad (5)$$

where

$(Q_s)_{ms}$ = represents summer water use in gallons per unit per day
P_s = summer price of water
V = home value in $1,000

In order to produce estimates of 1980 and 1985 consumption which depend on actual weather in those years, the summer equations are adjusted by the weather adjustment factor $(MD_i/MD_n)^e$, where e is the moisture deficit elasticity. This adjustment factor accounts for the deviation from normal weather conditions to permit a more accurate comparison of forecast results to the recorded water use. All other forecasts assumed normal weather conditions for which the weather factor assumes the value of 1. Adjustment of the weather (moisture deficit) factor required knowledge of the average moisture deficit for the Aridwest area, as well as the moisture deficit for the summer of 1980 and 1985. Averages for 29 years of monthly temperature and precipitation were used to calculate the long-term, or normal, moisture deficit using the formula:

$$MD = (PE - 0.6R) \quad (6)$$

where

MD = summer moisture deficit
PE = summer potential evapotranspiration
R = summer precipitation

Potential evapotranspiration (PE) was calculated using Thornthwaite's equation (Dunne and Leopold, Water in Environmental Planning, 1978). The actual (1980 and 1985) and normal moisture deficit data were entered into IWR-MAIN for calibration for the respective years.

The weather adjustment factors required calculation of the moisture deficit elasticity (e), which was estimated from residential summer outdoor water use from 1977 to 1984. Summer outdoor water use is calculated as the average water use in June, July, and August minus the domestic, or indoor, water use. Domestic water use is represented by the lowest average monthly value in gallons per day per account (GPD per account). Using water use records from AWU, domestic water use is determined to be 308.9 GPD per account (January) for single family, 458.45 GPD per account (January) for duplex-triplex, and 2,367.1 GPD per account (March)

for apartments. Summer outdoor water use for the three residential sectors is also provided by AWU. Regressions of summer outdoor water use on moisture deficit for the three-month periods produced functions of:

$$O_{sf} = 537.1 + 101.1 * MD$$
$$O_{dt} = 1961.0 + 8.1 * MD$$
$$O_{ap} = 8383 - 4.634 * MD$$

where O_{sf}, O_{dt}, and O_{ap} are the three-month outdoor water use for single-family, duplex-triplex, and apartment, respectively. Summer outdoor water use in apartments showed no significant responsiveness to weather, therefore no adjustments for weather were made for this sector. Elasticity for the single-family, or residential metered and sewered sector, of 0.7 was entered into the ARIDWEST.WOR file, and the weather adjustment factor was calculated by IWR-MAIN.

Calibration of the residential equations to local conditions required an adjustment of the summer equations for winter irrigation. The distribution of outdoor water use shows that 12 percent of outdoor water use occurs in the winter months (November-April) for single-family and duplex-triplex. The IWR-MAIN System equations for winter water use do not account for winter outdoor use, while the summer water use equations account for all outdoor water use. Thus, the coefficient for the sprinkling demand term in the summer equation is increased to incorporate the winter irrigation. The sprinkling demand term in the summer use equation divided by the percent of summer outdoor use (88 percent) provides the revised formula for summer demand. IWR-MAIN estimates of water use in winter (or indoor use) will be lower than actual records for the winter months due to the shifting of winter irrigation into summer estimates. However, the "winter" equation should provide reliable estimates of indoor water usage.

Flat Rate and Apartment Models

The winter demand by flat rate and sewered and apartment units is estimated by IWR-MAIN using the following equations:

$$(Q_d)_{fs,ap} = (28.9 + 1.576V + 33.6D_p) \quad (7)$$

where

$(Q_d)_{fs}$ = winter water use in flat rate and sewered units in gallons per unit per day
$(Q_d)_{ap}$ = winter water use in apartments in gallons per unit per day
V = home value
D_p = persons per household

The summer demand equation for flat rate and sewered is:

$$(Q_s)_{fs} = (0.41*44.573*V^{0.783}) * (MD_i/MD_n)^e * 2.0 + (Q_d)_{fs} \quad (8)$$

The equation for master-metered apartments is:

$$(Q_s)_{ap} = 1.433*(Q_d)_{ap} \quad (9)$$

As with single residences, the summer demand equations for flat rate and sewered dwellings were adjusted for weather variations for 1980 and 1985. However, since the IWR-MAIN System does not automatically adjust the water use for this sector, the equation intercept has adjusted by the weather factor and replaced in the ARIDWEST.WOR file for the calibration runs. The adjustments for weather in 1980 and 1985 were for verification purposes only and were not utilized in forecasts.

Preliminary estimates of flat rate and apartment water use indicated a tendency to overestimate expected summer flat rate and apartment water use per unit. This discrepancy is most likely attributable to the differences in the classification of housing types used by the socioeconomic data sources and the utility records. While AWU reports residential customers as single-family, duplex-triplex, and apartments, the housing data provided externally used a format of one-, two-, three-family and more, and mobile home units. Furthermore, the classification of housing types used by the IWR-MAIN System does not provide perfect compatability with either format. However, at the total residential level the estimates of annual water use based on the U.S. Census and city housing data closely replicate the total annual water use by residential customers recorded by AWU.

Adjustment of Commercial/Institutional Coefficients

IWR-MAIN computes water use in 23 commercial categories based on employment data. The number of employees in each category is multiplied by per employee use coefficients. The commercial water use coefficients were obtained from a survey of water use for 2,261 establishments located in 41 cities in the United States. As a part of this sample, a total of 342 establishments were located in the Census region which includes Aridwest.

In order to verify the applicability of these national average coefficients for Aridwest, the regional coefficients and coefficients obtained through a list of 186 AWU 1984 customers using 10 million gallons per year were examined. Three types of adjusted coefficients were used in place of the coefficients contained in the IWR-MAIN library.

(1) For six commercial/institutional categories, per employee coefficients were determined based on the actual consumption records shown on the 1984 AWU listing.

(2) For four categories, the employment accounted for by the large-quantity customers was insufficient to represent the per employee coefficient for the entire category. Weighted-average coefficients were calculated for these categories based on the employment accounted for by the large-quantity user (see example of similar calculations for industrial categories in the following section).

(3) For five categories, regional-use coefficients were used, since no members of these categories were found in the 1984 AWU listing.

Nine coefficients out of 23 were left unchanged in the IWR-MAIN libary, since no local or regional observations were available.

Adjustment of Coefficients for Manufacturing (Industrial)

The IWR-MAIN System estimates water purchases by manufacturing establishments using separate per employee coefficients for 198 different SIC classifications. The Library of Water Use Coefficients of IWR-MAIN contains national average per employee usage coefficients that were developed based on a survey of about 10,000 plants conducted by the Bureau of the Census (1982 Census of Water Use in Manufacturing). These coefficients were verified as to their accuracy in reflecting local industrial demands in Aridwest as described below.

A listing of AWU 1984 customers using 10 million gallons or more per year was used to calculate per employee water use for the largest industrial water customers based on employment information in each establishment. The per employee coefficients generated from the AWU records and the 1982 census of sanitary use coefficients were used to calculate weighted coefficients for the entire industrial category. For example, total employment for SIC 203 (preserved fruits and vegetables) was 679 employees. One plant from this group with 58 employees was found on the AWU list and its water use was 1,444.5 gallons per employee per day. The sanitary use coefficient was 81.0 gallons per employee per day. The weighted average coefficient was calculated as:

$$C_{SIC\ 203} = [(1444.5 * 58) + (81.0 * 621)]/(679) = 197.5 \text{ gals/emp/day}$$

For the remaining industries not found on the largest user list, the library coefficients were adjusted to reflect only sanitary use (restrooms, lunchrooms, and cafeterias) at the two- and three-digit SIC levels reported in the 1982 Census survey. The AWU 1980 records show that approximately 2.4 MGD was sold to industry, thus indicating that the city water is used by many industries primarily for sanitary purposes.

MODEL RUN

The results of the IWR-MAIN water use forecast for 1980 are not substantially different from the actual 1980 water use for the AWU service area. Estimated total municipal water use is 2.3 percent over the actual total municipal water use, indicating that the calibration procedures were unnecessary. These comparisons between actual AWU water consumption and IWR-MAIN estimates are shown in Table A-1.

The following is the complete data file shown as inputted to the IWR-MAIN data entry screens for this example. The revised library of coefficients file ARIDWEST.WOR, the IWR-MAIN water use reports for the years 1980, 1990, and 2000, and the coverage output file ARIDWEST.COV are also included.

TABLE A-1

COMPARISONS OF ACTUAL AND ESTIMATED WATER USE (1980)
(MGD)

	Actual Average Day Annual Water Use AWU Billing Records (1)	PMCL IWR-MAIN Estimate of Average Day Annual Water Use AWU Service Area*	
		Unadjusted for Existing Conservation (2)	Adjusted for Existing Conservation (3)
Metered and sewered	45.567	44.160	42.427
Flat rate	1.758	3.526	3.381
Master-metered	5.435	6.529	6.231
Total residential	52.760	54.215	52.039
Commercial	21.931	23.923	23.923
Industrial	2.439	2.930	2.930
Total metered use	77.130	81.068	78.892

*Water use estimate shown is adjusted for 1980 weather conditions and winter sprinkling.

EXHIBIT A-1
INPUT DATA SCREENS

```
IWR MAIN System

Parameter Control Screen                    Type(s) of Forecasting

    Data Subgroups ('Y' if Desired)     1 - Internal Growth Models
                                        2 - Extrapolation of Local Historical
      Residential                       3 - Direct External Projections
       Y Flat Rate-Sewered
       _ Flat Rate-Unsewered                 FORECAST          FORECAST
       Y Metered-Sewered                  YEAR  METHOD      YEAR  METHOD
       Y Master Metered Apartment         1990  1 _ 3       ____  - - -
                                          2000  1 _ 3       ____  - - -
    Y Commercial/Institutional            ____  - - -       ____  - - -
                                          ____  - - -       ____  - - -
    Y Industrial                          ____  - - -       ____  - - -
                                          ____  - - -       ____  - - -
    Y Public/Unaccounted (entry does      ____  - - -       ____  - - -
        not affect default loss and       ____  - - -       ____  - - -
        free service calculations)        ____  - - -       ____  - - -
                                          ____  - - -       ____  - - -
    Y Conservation Data                   ____  - - -       ____  - - -
                                          ____  - - -       ____  - - -
  City Name: ARIDWEST USA_____

          F1-Help, F2-return to menu, F4-Blank field, PgDn-Enter Data
```

```
IWR MAIN System                                          Screen No. 1.1

          Municipal Data - Base Year Data

Required data --                                      ARIDWEST USA
    Data include central city? (Y=1)  1          .PRN file requested? (Y=1) .
    Calendar year of base year data 1980           Latitude  (degrees)     35
    Resident population     479899                 Longitude (degrees)    110
    Median household income (1980$)      22024
    Total base year employment     197438  5 yrs before base year     168486

Choose one --
  1.  Dept. Commerce Composite Const. Cost Index for base year (U.S.)  143.3
  2.  Alternate const. cost index for 1980 (CCAL) .....  for base year .....

Optional climatic data (in inches) --
             Enter actual values for calibration purposes only.
    Summer season --     normal  actual    Maximum-day --
      Evapotranspiration 18.24  .....       Evapotranspiration .....
      Precipitation       3.74  .....
      Moisture deficit   16.00  .....


F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore
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IWR MAIN System Screen No. 1.2

Optional base year income data (supply all three) --
Percent households with income less than $10,000 (1980$) .....
at least $10,000 but less than $20,000 (1980$) .....
at least $20,000 but less than $30,000 (1980$) .....

Optional employment data (supply any pair) --

SIC 1500-1799 employment - base year	8370	5 yrs prior	7661
SIC 2000-3999 employment - base year	35893	5 yrs prior	29823
SIC 4000-4999 employment - base year	10639	5 yrs prior	9959
SIC 5000-5199 employment - base year	9712	5 yrs prior	8274
SIC 5200-5999 employment - base year	29987	5 yrs prior	25447
SIC 6000-6799 employment - base year	7256	5 yrs prior	6196
SIC 7000-8999 employment - base year	39262	5 yrs prior	32681
SIC 9100-9799 employment - base year	56319	5 yrs prior	48445

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System Screen No. 2.1

Municipal Data - Residential Subgroups - Flat Rate Sewered

Base Year Property Value Ranges Low ($100s)	High	Persons No/Unit	Assessment Factor	Density Units/Acre	No of Units In Range
0	99.99	2.23	...	4.00	1693
100	149.99	2.92	...	4.00	2334
150	199.99	2.92	...	4.00	2515
200	254.99	2.73	...	4.00	1313
255	299.99	2.40	...	4.00	1256
300	349.99	2.16	...	4.00	452
350	399.99	2.29	...	4.00	206
400	509.99	3.37	...	4.00	413
510	999.99	4.00	...	4.00	2
.....	.....	....	...	....	.....
.....	.....	....	...	....	.....
.....	.....	....	...	....	.....
.....	.....	....	...	....	.....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System Screen No. 4.1

Municipal Data - Residential - Metered Sewered

Base Year Property Value Ranges Low ($100s)	High	Price of Water Annual $/K-Gal	Summer $/K-Gal	Assess Factor	Density Units /Acre	No of Units in Range	Bill Difference $/Bill Annual	Period Summer
0	99.99	.754	.486	....	4.00	4496	2.527	1.651
100	149.99	.787	.486	....	4.00	5543	2.709	2.306
150	199.99	.799	.486	....	4.00	8276	2.771	2.624
200	254.99	.816	.582	....	4.00	10588	2.867	1.068
255	299.99	.831	.582	....	4.00	10321	2.947	1.362
300	349.99	.826	.582	....	4.00	11034	2.919	1.627
350	399.99	.828	.582	....	4.00	8717	2.935	1.881
400	500.99	.832	.582	....	4.00	13654	2.953	2.239
510	599.99	.822	.687	....	4.00	7848	2.900	0.024
600	799.99	.926	.687	....	4.00	8015	2.204	0.686
800	999.99	.914	.687	....	4.00	3379	1.868	1.524
1000	4000.00	.908	.899	....	4.00	3011	-0.252	3.728
.....	.....	.....	.....	....	.....	.....	.....	.....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System Screen No. 5.1

Municipal Data - Residential - Master Metered Apartments

Base Year Property Value Ranges Low ($100s)	High	Persons No/Unit	Assessment Factor	No of Units in Range
0	99.99	2.23	....	8336
100	149.99	2.92	....	5954
150	199.99	2.92	....	7627
200	254.99	2.73	....	6540
255	299.99	2.40	....	5792
300	349.99	2.16	....	1182
350	399.99	2.29	....	1151
400	509.99	3.37	....	271
510	1000.00	3.14	....	183
.....	.....	.....	....	.....
.....	.....	.....	....	.....
.....	.....	.....	....	.....
.....	.....	.....	....	.....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System Screen No. 6.1

Municipal Data - Commercial Employment

Total Employment

	Description			Description	
C001	Miscellaneous Commercial	30301	C013	Hotels, Restaurants	9118
C002	Vocational School	1079	C014	Electric, Gas Utilities	3585
C003	Miscellaneous Retail	12667	C015	Public Administration	56319
C004	Boarding Houses	48	C016	Schools, Universities	10438
C005	Transportation Terminal	154	C017	Race Tracks	.....
C006	Barbers, Cleaning	1016	C018	Labs, Water Utilities	2259
C007	Power Laundries	.....	C019	Health Services	610
C008	Landscaping	274	C020	Medical Offices, Bakeries	1664
C009	Miscellaneous Wholesale	18368	C021	Nursing Facilities	489
C010	Recreational Facilities	292	C022	Hospitals	3855
C011	Food and Auto Retail	9264	C023	Zoological, etc. Gardens	.....
C012	Dance Studios	18			

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System Screen No. 7.1

Municipal Data - Industrial Employment

Total Employment

SIC	Description		SIC	Description	
201	Meat Products	282	209	Misc Foods & Kindred prod	281
2011	Meat Packing Plants	.....	211	Cigarettes	.....
2013	Sausages &Prepared Meats	.....	212	Cigars	.....
2016	Poultry Dressing Plants	.....	213	Chewing & Smoking Tobacco	.....
2017	Poultry & Egg Processing	.....	214	Tobacco Stemming&Redrying	.....
202	Dairy Products	316	221	Weaving Mills, Cotton	.....
203	Preserved Fruits & Veggys	679	222	Weaving Mills, Synthetics	.....
204	Grain Mill Products	365	223	Weaving&Finish Mills,Wool	.....
205	Bakery products	291	224	Narrow Fabric Mills	.....
2051	Bread, Cake & Rel. Prods	.....	225	Knitting Mills	11
2052	Cookies & Crackers	.....	226	Textile Finishng,exc.Wool	.....
206	Sugar & Confectionery prd	37	227	Floor Covering Mills	.....
207	Fats & Oils	56	228	Yarn & Thread Mills	2
208	Beverages	306	229	Misc. Textile Goods	54
2082	Malt Beverages	.....	230	Apparel&Other Textile Prd	14962
2086	Bottled& Canned Soft Drks	.....	241	Logging Camps&Lg Contrctr	.....
2087	Flavoring Extracts&Syrup	.....			

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System
Municipal Data - Industrial Employment

Screen No. 7.2

SIC	Description	Total Employment
242	Sawmills & Planing Mills	.....
243	Millwork,Plywood&Str.Mems	734
244	Wood Containers	13
245	Wood Bldgs & Mobile Homes	26
249	Misc. Wood Products	38
251	Household Furniture	86
252	Office Furniture	.....
253	Public Bldg & Rel. Furn.	.....
254	Partitions & Fixtures	24
259	Misc. Furniture &Fixtures	10
261	Pulp Mills	.....
262	Paper Mills,exc.BldgPaper	.....
263	Paperboard Mills	.....
264	Misc. Conv. Paper Prods	675
265	Paperboard Containers&Box	307
266	Bldg Paper & Board Mills	.....
270	Printing & Publishing	1629
281	Industrial Inorganic Chem	2
282	Plastics Materials&Synths	11
283	Drugs	14
2831	Biological Products	.....
2833	Medicinals & Botanicals	.....
2834	Pharmaceutical Preps.	.....
284	Soap,Cleaners&Toilet Good	.....
285	Paints & Allied Products	100
286	Industrial Organic Chems.	.....
2861	Gum & Wood Chemicals	.....
2865	Cyclic Crudes &Intermeds	.....
2869	Industrial Organic Chems	.....
287	Agricultural Chemicals	16
289	Misc. Chemical Products	4
291	Petroleum Refining	164
295	Paving &Roofing Materials	.....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System
Municipal Data - Industrial Employment

Screen No. 7.3

SIC	Description	Total Employment
299	Misc. Petrol & Coal Prods	.....
301	Tires & Inner Tubes	.....
302	Rubber &Plastics Footwear	.....
303	Reclaimed Rubber	.....
304	Rubber&Plastic Hose&Beltg	.....
306	Fabricated Rubber Prods	242
307	Misc Plastics Products	341
311	Leather Tanning&Finishing	.....
313	Boot&Shoe Cut Stock&Findg	111
314	Footwear exc. Rubber	2200
315	Leather Gloves & Mittens	47
316	Luggage	.....
317	Handbags&Pers.Leather Prs	.....
319	Leather Goods, nec	7
321	Flat Glass	.....
322	Glass&Gware,pressed|Blown	.....
323	Prods of Purchased Glass	5
324	Cement, Hydraulic	157
325	Structural Clay Products	10
326	Pottery &Related Products	.....
327	Concrete,Gypsum&Plast Prs	616
328	Cut Stone &Stone Products	.....
329	Misc Nonmetal Mineral Prs	101
331	Blast Furn &BAS Steel Prs	508
3312	Blast Furns &Steel Mills	.....
3313	Electrometallurgical Prs	.....
3315	Steel Wire &Rel Products	.....
3316	Cold Finish of Steel Prs	.....
3317	Steel Pipe & Tubes	.....
332	Iron & Steel Foundries	96
3321	Gray Iron Foundries	.....
3322	Malleable Iron Foundries	.....
3324	Steel Investment Foundrs	.....
3325	Steel Foundries, nec	.....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System Screen No. 7.4
Municipal Data - Industrial Employment

SIC	Description	Total Employment	SIC	Description	
333	Primary Nonferrous Metals	1420	3462	Iron & Steel Forgings	.....
334	Secondary Nonferrous Metl	.....	3463	Nonferrous Forgings	.....
335	Nonferrous Rolling&Drawin	255	3465	Automotive Stampings	.....
336	Nonferrous Foundries	238	3466	Crowns & Closures	.....
339	Misc Primary Metal prods	.....	3469	Metal Stampings, nec	.....
341	Metal Cans&Shipg Ctainers	.....	347	Metal Services, nec	79
342	Cutlery,HandTools&Hardwre	.....	348	Ordnance & Accessries,nec	41
343	Plumbing&Heating, ex Elec	.....	349	Misc. Fabricated Met Prds	12
344	Fabrictd Struct Steel Prs	843	351	Engines & Turbines	40
3441	Fabricated Structl Metal	.....	352	Farm & Garden Machinery	.....
3442	Metal Doors, Sash & Trim	.....	353	Construction&Rel Machinry	.....
3443	Fabricated Plate Work	.....	3531	Construction Machinery	.....
3444	Sheet Metal Work	.....	3532	Mining Machinery	.....
3446	Architectural Metal Work	.....	3533	Oil Field Machinery	.....
3448	Prefab Metal Buildings	.....	3534	Elevatrs&Moving Stairway	.....
3449	Misc. Metal Work	.....	3535	Conveyors&Convey Equipmt	.....
345	Screw Machine Prs,bolts,e	10	3536	Hoists, Cranes&Monorails	.....
346	Metal Forgings &Stampings	9	3537	Industrial Trucks&Tractr	.....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System Screen No. 7.5
Municipal Data - Industrial Employment

SIC	Description	Total Employment	SIC	Description	
354	Metalworking Machinery	129	3599	Machinery,exc Electr nec	.....
355	Specl Industrial Mchinery	.....	361	Electr Distribting equipt	202
356	Genrl Industrial Mchinery	376	362	Elect Industrial appratus	135
357	Office&Computing Machines	.....	363	Household Appliances	100
3572	Typewriters	.....	364	Elect Lighting&wiring eqp	95
3573	Electo Computing Equipmt	.....	365	Radio & TV Recievng equip	236
3574	Calcg &Accountg Machines	.....	366	Communication Equipment	1228
3576	Scales&Balances,exc. Lab	.....	367	Electronic Components&acc	1605
3579	Office Machines, nec	.....	3671	Electron Tubes,Recv Type	.....
358	Refrigeration&Svc Mchinry	183	3672	Cath Ray Tele Pict Tubes	.....
3581	Auto Merchandising Mchns	.....	3673	Electron tubes,Xmit Type	.....
3582	Commercial Laundry Eqpmt	.....	3674	Semiconductors&Rel devcs	.....
3585	Refrig & Heating Equipmt	.....	3675	Electronic Capacitors	.....
3586	Measuring&Dispensng Pmps	.....	3676	Electronic Resistors	.....
3589	Svc Indstry Mchinery,nec	.....	3677	Electronic Coils&Xformrs	.....
359	Misc. Machinery,exc.Elect	187	3678	Electronic Connectors	.....
3592	Carbs,Pistons,rings,valv	.....	3679	Electronic Cmponents,nec	.....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System — Screen No. 7.6

Municipal Data - Industrial Employment

Total Employment

SIC	Description		SIC	Description	
369	Misc. Electr Equip&suplys	355	379	Misc Transportn Equipment	....
371	Motor Vehicles &Equipment	491	381	Engineering&Sci Instrment	1
3711	Motor Vehcles&car bodies	....	382	Measuring&Controlling dvc	359
3713	Truck & Bus Bodies	....	383	Optical Instrmnts &lenses	....
3714	Motor vhicle parts &Accs	....	384	Medcl Instrumnts& supplys	16
3715	Truck Trailers	....	385	Opthalmic Goods	113
372	Aircraft & Parts	11	386	Photographic Eqpmt &Supps	....
3721	Aircraft	....	387	Watches, Clocks&clokcases	....
3724	Aircraft engs &eng parts	....	391	Jewelry, Silverware&platd	31
3728	Aircraft Equipment, nec	....	393	Musical Instruments	....
373	Ship&Boat Bldg &Repairing	....	394	Toys & Sporting Games	1068
374	Railroad Equipment	....	395	Pens,Pencils,Offc&art Sup	....
375	Motorcycles,bicycle&parts	....	396	Costume Jewelry & Notions	75
376	Guided Missiles,space veh	....	399	Misc. Manufactures	66

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System — Screen No. 9.1

Projection Data for Internal Growth Models

Year >Base	Populatn	Medn HH Income (1980$)	Total Employmnt	Total No. Househlds	% Households w/Income (1980$) <10,000	10,000-- <20,000	20,000-- <30,000
1990	586432	25851	226958	172413	....	....	....
2000	679366	28583	277855	196469	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System — Screen No. 9.3

Projection Data for Internal Growth Models

Employment by Industry Group (SIC Codes)

Year >Base	1500-- 1799	2000-- 3999	4000-- 4999	5000-- 5199	5200-- 5999	6000-- 6799	7000-- 8999	9100-- 9799
1990	12657	50147	10363	9506	33276	8236	40773	62000
2000	14337	61801	13526	12053	47491	11137	52610	64900
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System — Screen No. 14.1.1

Direct External Projections: 1990 - Residential

Category & Value Range Group	No. Units in Group	Category & Value Range Group	No. Units in Group
FWG1	....	FPG1	....
FWG2	....	FPG2	....
FWG3	....	FPG3	....
FWG4	....	FPG4	....
FWTL	12315	FPTL	....
MWG1	36936	APG1	....
MWG2	57417	APG2	....
MWG3	20712	APG3	....
MWG4	....	APG4	....
MWTL	115065	APTL	45033

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System — Screen No. 14.1.4

Direct External Projections: 1990 - Industrial

Category	Employment	Category	Employment	Category	Employment
I001	.....	I018	.....	I035	.....
I002	.....	I019	.....	I036	.....
I003	.....	I020	.....	I037	.....
I004	.....	I021	.....	I038	.....
I005	.....	I022	.....	I039	.....
I006	.....	I023	.....	I040	.....
I007	860	I024	.....	I041	.....
I008	462	I025	.....	I042	.....
I009	.....	I026	.....	I043	.....
I010	.....	I027	.....	I044	.....
I011	.....	I028	.....	I045	.....
I012	.....	I029	.....	I046	.....
I013	.....	I030	.....	I047	1009
I014	.....	I031	.....	I048	.....
I015	.....	I032	.....	I049	.....
I016	.....	I033	.....	I050	.....
I017	.....	I034	.....	I051	.....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System — Screen No. 14.1.5

Direct External Projections: 1990 - Industrial

Category	Employment	Category	Employment	Category	Employment
I052	.....	I069	.....	I086	.....
I053	.....	I070	.....	I087	.....
I054	.....	I071	.....	I088	.....
I055	.....	I072	.....	I089	.....
I056	.....	I073	.....	I090	683
I057	.....	I074	.....	I091	.....
I058	.....	I075	.....	I092	.....
I059	.....	I076	.....	I093	.....
I060	.....	I077	.....	I094	.....
I061	.....	I078	.....	I095	.....
I062	.....	I079	.....	I096	.....
I063	.....	I080	.....	I097	.....
I064	.....	I081	.....	I098	.....
I065	.....	I082	.....	I099	.....
I066	.....	I083	.....	I100	.....
I067	.....	I084	.....	I101	1909
I068	.....	I085	.....	I102	.....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System Screen No. 14.1.7

Direct External Projections: 1990 - Industrial

Category	Employment	Category	Employment	Category	Employment
I154	.....	I170	.....	I186	.....
I155	.....	I171	.....	I187	501
I156	.....	I172	.....	I188	.....
I157	.....	I173	.....	I189	.....
I158	.....	I174	.....	I190	.....
I159	.....	I175	.....	I191	.....
I160	.....	I176	.....	I192	.....
I161	.....	I177	.....	I193	.....
I162	.....	I178	.....	I184	.....
I163	.....	I179	.....	I195	.....
I164	.....	I180	.....	I196	.....
I165	.....	I181	.....	I197	.....
I166	.....	I182	.....	I198	.....
I167	.....	I183	.....	I199	.....
I168	.....	I184	.....	I200	.....
I169	.....	I185	.....		

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System Screen No. 14.2.1

Direct External Projections: 2000 - Residential

Category & Value Range Group	No. Units in Group	Category & Value Range Group	No. Units in Group
FWG1	.....	FPG1	.....
FWG2	.....	FPG2	.....
FWG3	.....	FPG3	.....
FWG4	.....	FPG4	.....
FWTL	13930	FPTL	.....
MWG1	45837	APG1	.....
MWG2	62731	APG2	.....
MWG3	22395	APG3	.....
MWG4	.....	APG4	.....
MWTL	130963	APTL	51576

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System Screen No. 14.2.4

Direct External Projections: 2000 - Industrial

Category	Employment	Category	Employment	Category	Employment
I001	.....	I018	.....	I035	.....
I002	.....	I019	.....	I036	.....
I003	.....	I020	.....	I037	.....
I004	.....	I021	.....	I038	.....
I005	.....	I022	.....	I039	.....
I006	.....	I023	.....	I040	.....
I007	1116	I024	.....	I041	.....
I008	600	I025	.....	I042	.....
I009	.....	I026	.....	I043	.....
I010	.....	I027	.....	I044	.....
I011	.....	I028	.....	I045	.....
I012	.....	I029	.....	I046	.....
I013	.....	I030	.....	I047	1230
I014	.....	I031	.....	I048	.....
I015	.....	I032	.....	I049	.....
I016	.....	I033	.....	I050	.....
I017	.....	I034	.....	I051	.....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System Screen No. 14.2.5

Direct External Projections: 2000 - Industrial

Category	Employment	Category	Employment	Category	Employment
I052	.....	I069	.....	I086	.....
I053	.....	I070	.....	I087	.....
I054	.....	I071	.....	I088	.....
I055	.....	I072	.....	I089	.....
I056	.....	I073	.....	I090	718
I057	.....	I074	.....	I091	.....
I058	.....	I075	.....	I092	.....
I059	.....	I076	.....	I093	.....
I060	.....	I077	.....	I094	.....
I061	.....	I078	.....	I095	.....
I062	.....	I079	.....	I096	.....
I063	.....	I080	.....	I097	.....
I064	.....	I081	.....	I098	.....
I065	.....	I082	.....	I099	.....
I066	.....	I083	.....	I100	.....
I067	.....	I084	.....	I101	2006
I068	.....	I085	.....	I102	.....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System Screen No. 14.2.7

Direct External Projections: 2000 - Industrial

Category	Employment	Category	Employment	Category	Employment
I154	.....	I170	.....	I186	.....
I155	.....	I171	.....	I187	616
I156	.....	I172	.....	I188	.....
I157	.....	I173	.....	I189	.....
I158	.....	I174	.....	I190	.....
I159	.....	I175	.....	I191	.....
I160	.....	I176	.....	I192	.....
I161	.....	I177	.....	I193	.....
I162	.....	I178	.....	I184	.....
I163	.....	I179	.....	I195	.....
I164	.....	I180	.....	I196	.....
I165	.....	I181	.....	I197	.....
I166	.....	I182	.....	I198	.....
I167	.....	I183	.....	I199	.....
I168	.....	I184	.....	I200	.....
I169	.....	I185	.....		

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen Numbers
F6-Copy down __ rows, Arrows move cursor, PgDn & PgUp change screen, Esc-Ignore

IWR MAIN System Selection of Measures and Year of Initiation Screen 15.1

Enter year for those measures desired

Number	Measure Description	Year
1	Public Education Program	1980
2	Metering	....
3	Pressure Reduction	....
4	Pricing Policy (Rate Reform)	....
5	Rationing (Per Capita)	....
6	Sprinkling Restrictions	....
7	Industrial Reuse/Recycle	....
8	Commercial Reuse/Recycle	....
9	Leak Detection and Repair	1966
10	Retrofit of Showerheads and Toilets	....
11	Moderate Plumbing Code	1977
12	Advanced Plumbing Code	....
13	Low-Water Use Landscaping (New)	1971
14	Low-Water Use Landscaping (Retrofit)	....
15	User-Specified Measure Number 1	....
16	User-Specified Measure Number 2	....
17	User-Specified Measure Number 3	....
18	User-Specified Measure Number 4	....

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen numbers
Up and down arrows move cursor, PgDn & PgUp change screen

IWR MAIN System Selection of Sectors for Each Measure Screen 15.2

Enter a Y for each desired sector for each measure

SECTORS: MEASURES	RESIDENTIAL METERED	RESIDENTIAL FLATRATE	RESIDENTIAL APARTMNT	COMMERCL	INDUSTRL	PUBLIC & OTHER	UNACCOUNT
EDUCATION	Y	Y	Y	.	.	.	.
LEAK REPAIR	.	.	.	.	.	.	Y
MODERATE CODE	Y	Y	Y	.	.	.	.
LANDSCAPE-NEW	Y	Y	Y	.	.	.	.

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen numbers
Arrows move cursor, PgDn & PgUp change screen

IWR MAIN System Determination of Reduction Factors Screen 16.2

INDOOR USE Enter Reduction Factors between 0.000 and 1.000

SECTORS: MEASURES	RESIDENTIAL METERED	RESIDENTIAL FLATRATE	RESIDENTIAL APARTMNT	COMMERCL	INDUSTRL	PUBLIC & OTHER	UNACCOUNT
EDUCATION	0.035	0.035	0.035				
LEAK REPAIR							0.273
MODERATE CODE	0.079	0.152	0.152				
LANDSCAPE-NEW	0.000	0.000	0.000				

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen numbers
F6-Copy from previous dimension, Arrows move cursor, PgDn & PgUp change screen

IWR MAIN System Determination of Reduction Factors Screen 16.3
OUTDOOR USE Enter Reduction Factors between 0.000 and 1.000

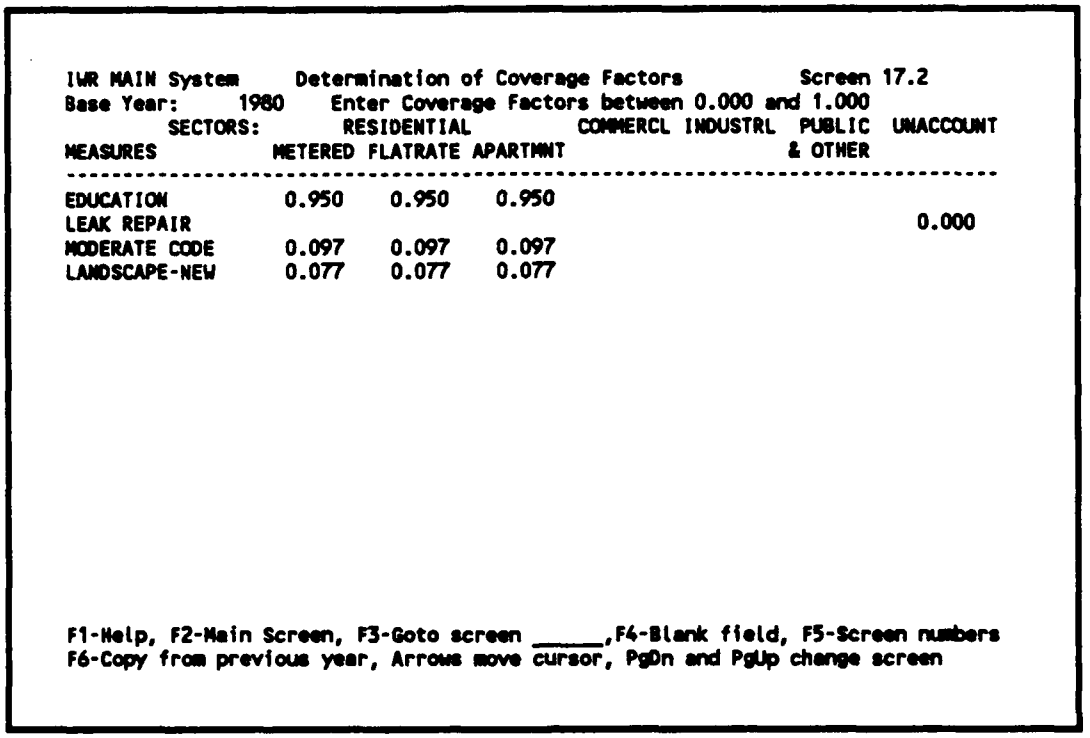
SECTORS: MEASURES	RESIDENTIAL METERED	FLATRATE	APARTMNT	COMMERCL	INDUSTRL	PUBLIC & OTHER	UNACCOUNT
EDUCATION	0.035	0.035	0.035				
LEAK REPAIR							0.273
MODERATE CODE	0.000	0.000	0.000				
LANDSCAPE-NEW	0.052	0.032	0.023				

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen numbers
F6-Copy from previous dimension, Arrows move cursor, PgDn & PgUp change screen

IWR MAIN System Determination of Reduction Factors Screen 16.4
MAX-DAY USE Enter Reduction Factors between 0.000 and 1.000

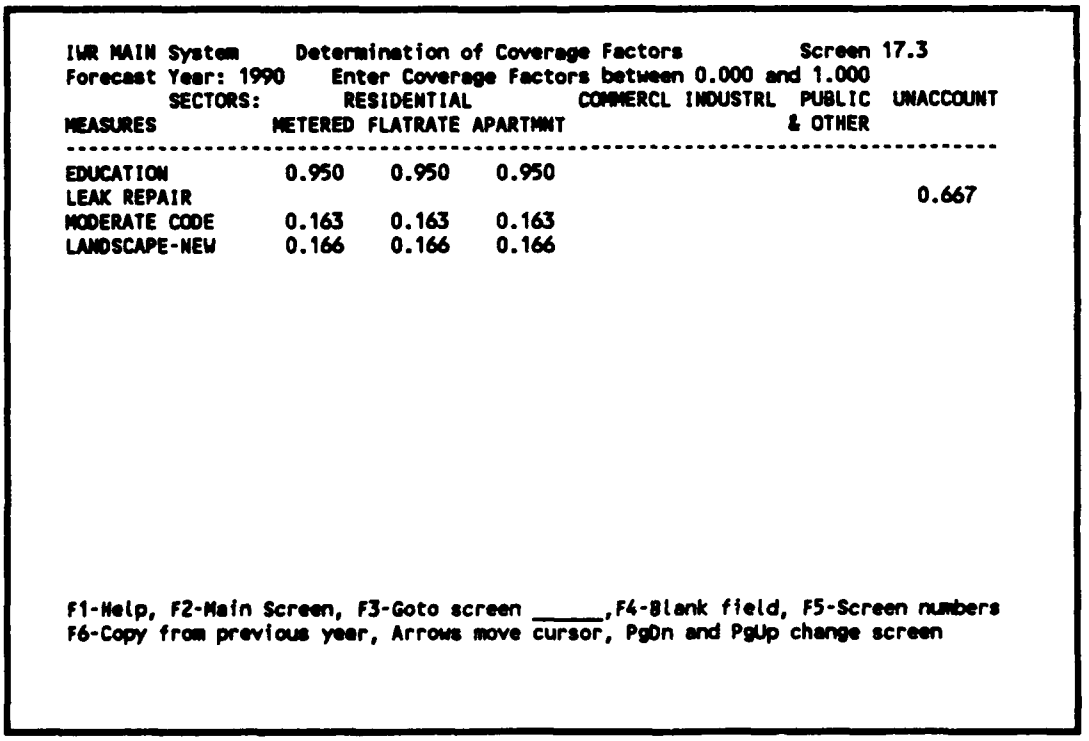
SECTORS: MEASURES	RESIDENTIAL METERED	FLATRATE	APARTMNT	COMMERCL	INDUSTRL	PUBLIC & OTHER	UNACCOUNT
EDUCATION	0.035	0.035	0.035				
LEAK REPAIR							0.273
MODERATE CODE	0.079	0.152	0.152				
LANDSCAPE-NEW	0.052	0.032	0.023				

F1-Help, F2-Main Screen, F3-Goto screen _____, F4-Blank field,F5-Screen numbers
F6-Copy from previous dimension, Arrows move cursor, PgDn & PgUp change screen



```
IWR MAIN System     Determination of Coverage Factors          Screen 17.2
Base Year:    1980    Enter Coverage Factors between 0.000 and 1.000
        SECTORS:       RESIDENTIAL          COMMERCL INDUSTRL  PUBLIC  UNACCOUNT
MEASURES          METERED FLATRATE APARTMNT                    & OTHER
-------------------------------------------------------------------------------
EDUCATION         0.950    0.950    0.950
LEAK REPAIR                                                              0.000
MODERATE CODE     0.097    0.097    0.097
LANDSCAPE-NEW     0.077    0.077    0.077

F1-Help, F2-Main Screen, F3-Goto screen _____,F4-Blank field, F5-Screen numbers
F6-Copy from previous year, Arrows move cursor, PgDn and PgUp change screen
```



```
IWR MAIN System     Determination of Coverage Factors          Screen 17.3
Forecast Year: 1990    Enter Coverage Factors between 0.000 and 1.000
        SECTORS:       RESIDENTIAL          COMMERCL INDUSTRL  PUBLIC  UNACCOUNT
MEASURES          METERED FLATRATE APARTMNT                    & OTHER
-------------------------------------------------------------------------------
EDUCATION         0.950    0.950    0.950
LEAK REPAIR                                                              0.667
MODERATE CODE     0.163    0.163    0.163
LANDSCAPE-NEW     0.166    0.166    0.166

F1-Help, F2-Main Screen, F3-Goto screen _____,F4-Blank field, F5-Screen numbers
F6-Copy from previous year, Arrows move cursor, PgDn and PgUp change screen
```

IWR MAIN System Determination of Coverage Factors Screen 17.4
Forecast Year: 2000 Enter Coverage Factors between 0.000 and 1.000

SECTORS:	RESIDENTIAL			COMMERCL	INDUSTRL	PUBLIC	UNACCOUNT
MEASURES	METERED	FLATRATE	APARTMNT			& OTHER	
EDUCATION	0.950	0.950	0.950				
LEAK REPAIR							1.000
MODERATE CODE	0.275	0.275	0.275				
LANDSCAPE-NEW	0.240	0.240	0.240				

F1-Help, F2-Main Screen, F3-Goto screen _____,F4-Blank field, F5-Screen numbers
F6-Copy from previous year, Arrows move cursor, PgDn and PgUp change screen

EXHIBIT A-2
REVISED COEFFICIENT LIBRARY

```
1CONSTANT  (FOR IWR MAIN VERSION 5.1)
 E011 234.0            E012 1.451            E013 -45.9
 E014 -2.59            E021 28.9             E022 1.576
 E023 33.6             E041 30.2             E042 39.5
 E051 0.5453           E052 58.777           E053 -0.703
 E054 0.429            E061 385.0            E062 2.876
 E063 -285.8           E064 -4.35            E065 157.77
 E071 0.4658           E072 44.573           E073 0.783
 E091 0.4658           E092 44.573           E093 0.783
 E101 0.803            E102 -1.26            E111 2227.34
 E112 2.06             E113 0.413            E121 .000046485
 E122 0.118            E123 -10.4            E124 -1.25
 E125 0.931            E131 1609.59          E132 0.943
 E133 0.523            E151 1609.59          E152 0.943
 E153 0.523            E024 1.433
 ENDD
1CLIMELAS   (ELASTICITIES FOR WEATHER ADJUSTMENT FACTORS)
 MSSD 1.0
 ENDD
1COMLABEL
 C001 MISC. COMMERCIAL C002 VOC. SCHOOLS     C003 MISC. RETAIL
 C004 BOARDING HOUSES  C005 TRANSP. TERMINAL C006 BARBER, CLEANING
 C007 POWER LAUNDRIES  C008 LANDSCAPING      C009 MISC. WHOLESALE
 C010 RECREATION FACL. C011 FOOD AUTO RETAIL C012 DANCE STUDIOS
 C013 HOTELS, RESTRNTS C014 ELEC, GAS UTIL.  C015 PUBLIC ADMINIST.
 C016 SCHOOLS, UNIV.   C017 RACE TRACKS      C018 LABS, WTR UTIL.
 C019 HEALTH SERVICES  C020 MED. OFF. BAKERS C021 NURSING FACIL.
 C022 HOSPITALS        C023 ZOOLOGICAL GRDNS
 ENDD
1COMMUNIT
 C001 EMPLOYEES        C002 EMPLOYEES        C003 EMPLOYEES
 C004 EMPLOYEES        C005 EMPLOYEES        C006 EMPLOYEES
 C007 EMPLOYEES        C008 EMPLOYEES        C009 EMPLOYEES
 C010 EMPLOYEES        C011 EMPLOYEES        C012 EMPLOYEES
 C013 EMPLOYEES        C014 EMPLOYEES        C015 EMPLOYEES
 C016 EMPLOYEES        C017 EMPLOYEES        C018 EMPLOYEES
 C019 EMPLOYEES        C020 EMPLOYEES        C021 EMPLOYEES
 C022 EMPLOYEES        C023 EMPLOYEES
 ENDD
1COMMAVEG      EXPECTED USAGE VALUES
 C001 96.5             C002 76.5             C003 26.63
 C004 101.6            C005 187.8            C006 1022.01
 C007 273.9            C008 106.7            C009 40.1
 C010 832.7            C011 131.1            C012 70.600
 C013 494.3            C014 108.8            C015 125.20
 C016 300.7            C017 341.5            C018 442.85
 C019 125.3            C020 108.5            C021 307.7
 C022 204.36           C023 450.8
 ENDD
1COMMAXDY      EXPECTED USAGE VALUES
 C001 96.5             C002 76.5             C003 26.63
 C004 101.6            C005 187.8            C006 1022.01
 C007 273.9            C008 106.7            C009 40.1
 C010 832.7            C011 131.1            C012 70.600
 C013 494.3            C014 108.8            C015 125.20
 C016 300.7            C017 341.5            C018 442.85
 C019 125.3            C020 108.5            C021 307.7
```

```
C022 204.36          C023 450.8
ENDD
1INDLABEL
I001 201   MEAT PRODUCTS       I002 2011  MEAT PACKNG PLANTS
I003 2013  SAUSAGES, ETC.      I004 2016  POULTRY DRESSING
I005 2017  POULTRY & EGG DRSG  I006 202   DAIRY PRODUCTS
I007 203   PRSRVD FRUITS, VEG  I008 204   GRAIN MILL PRDCTS
I009 205   BAKERY PRODUCTS     I010 2051  BREAD, CAKE, ETC.
I011 2052  COOKIES, CRACKERS   I012 206   SUGAR & CONFECTNRY
I013 207   FATS & OILS         I014 208   BEVERAGES
I015 2082  MALT BEVERAGES      I016 2086  SOFT DRINKS
I017 2087  EXTRACTS, SIRUPS    I018 209   MISC. FOODS, ETC.
I019 211   CIGARETTES          I020 212   CIGARS
I021 213   CHEWNG & SMKNG TOB  I022 214   TOBACCO STEMMING
I023 221   COTTON WEAVING      I024 222   SYNTHETIC WEAVING
I025 223   WOOL WEAVING, FIN.  I026 224   NARROW FABRIC MLLS
I027 225   KNITTING MILLS      I028 226   TEXTILE FINISHING
I029 227   FLOOR COVERING MLS  I030 228   YARN & THREAD MLLS
I031 229   MISC. TEXTILE MLLS  I032 230   APPAREL, ETC.
I033 241   LOGGING CAMPS, ETC  I034 242   SAW & PLANING MLLS
I035 243   MILLWORK, PLYWOOD   I036 244   WOOD CONTAINERS
I037 245   WOOD BUILDINGS ETC  I038 249   MISC. WOOD PRODCTS
I039 251   HOUSEHOLD FRNITURE  I040 252   OFFICE FURNITURE
I041 253   PUBLIC BLDG. FURN.  I042 254   PARTITIONS, FIXTRS
I043 259   MISC. FURNITURE     I044 261   PULP MILLS
I045 262   PAPER MLLS,EXC.PPR  I046 263   PAPERBOARD MILLS
I047 264   MISC. CONV. PAPER   I048 265   PAPERBOARD CONTNRS
I049 266   BUILDNG PAPER, BRD  I050 270   PRINTING, PUBLSHNG
I051 281   IND. ORGANIC CHEM.  I052 282   PLASTICS, SYNTHTCS
I053 283   DRUGS               I054 2831  BIOLOGICAL PRODCTS
I055 2833  MEDICINALS, BOTAN.  I056 2834  PHARMACEUTICALS
I057 284   SOAP & TOILET GDS   I058 285   PAINTS & ALLIED PR
I059 286   IND. ORGANIC CHEM.  I060 2861  GUM & WOOD PRODCTS
I061 2865  CYCLIC CRUDES,INTR  I062 2869  ORGANIC CHEM. NEC
I063 287   AGRICULTURAL CHEM.  I064 289   MISC. CHEM. PRDCTS
I065 291   PETROLEUM REFINING  I066 295   PAVING & ROOFING
I067 299   MISC. PET. & COAL   I068 301   TIRES & TUBES
I069 302   RUBBER FOOTWEAR     I070 303   RECLAIMED RUBBER
I071 304   RUBBER HOSE, BELTG  I072 306   FABRIC.RUBBER, NEC
I073 307   MISC. PLASTICS PRD  I074 311   LEATHER TANNING
I075 313   BOOT, SHOE STOCK    I076 314   FOOTWEAR, EX. RUBR
I077 315   LEATHER GLOVES      I078 316   LUGGAGE
I079 317   HANDBAGS, ETC.      I080 319   LEATHER GOODS, NEC
I081 321   FLAT GLASS          I082 322   GLASS & GLASSWARE
I083 323   PURCHASD GLASS PRD  I084 324   HYDRAULIC CEMENT
I085 325   STRUCTURL CLAY PRD  I086 326   POTTERY & RELATED
I087 327   CONCRETE, GYPSUM    I088 328   CUT STONE & STONE
I089 329   MISC.NONMET.MINERL  I090 331   BLAST FURNC & STEL
I091 3312  FURNACES, STEEL ML  I092 3313  ELECTROMETALLURGCL
I093 3315  COLD WIRE & RELATD  I094 3316  COLD FINSHNG STEEL
I095 3317  STEEL PIPE & TUBES  I096 332   IRON, STEEL FOUNDR
I097 3321  GRAY IRON FOUNDRY   I098 3322  MALLEABLE IRON FND
I099 3324  STEEL INVSTMNT FND  I100 3325  STEEL FOUNDRY, NEC
I101 333   PRIMARY NONFERROUS  I102 334   SECONDARY NONFERRS
I103 335   NONFERROUS ROLLING  I104 336   NONFERROUS FOUNDRY
I105 339   MISC.PRIMARY METAL  I106 341   METAL CANS, CONTNR
I107 342   CUTLERY,HAND TOOLS  I108 343   PLUMBING, HEATING
I109 344   STRUCTRL STEEL PRD  I110 3441  FABRICATED STRCTRL
I111 3442  METAL DOORS, SASH   I112 3443  FABRICATED PLATE
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I113 3444  SHEET METAL WORK    I114 3446  ARCHITCTRL METAL
I115 3448  PREFAB METAL BLDGS  I116 3449  MISC. METAL WORK
I117 345   SCREW MACHNE PRODS  I118 346   METAL FORGINGS,ETC
I119 3462  IRON & STEEL FRGNG  I120 3463  NONFERROUS FORGNGS
I121 3465  AUTOMOTIVE STMPNGS  I122 3466  CROWNS & CLOSURES
I123 3469  METAL STMPNGS, NEC  I124 347   METAL SERVICES,NEC
I125 348   ORDNANCE & ACCESS.  I126 349   MISC. FAB. METAL
I127 351   ENGINES & TURBINES  I128 352   FARM, GARDEN MACH.
I129 353   CONSTR, RELTD MACH  I130 3531  CONSTRUCTION MACH.
I131 3532  MINING MACHINERY    I132 3533  OIL FIELD MACHNRY
I133 3534  ELEVATORS, ETC.     I134 3535  CONVEYORS, ETC.
I135 3536  HOISTS, CRANES      I136 3537  IND. TRUCKS, TRCTR
I137 354   METALWORKING MACH.  I138 355   SPEC. IND. MACHNRY
I139 356   GENERAL IND. MACH.  I140 357   OFFICE & COMPTNG
I141 3572  TYPEWRITERS         I142 3573  ELECTRONIC CMPUTNG
I143 3574  CALCULTNG, ACCNTG   I144 3576  SCALES,BALANCES
I145 3579  OFFICE MACH., NEC   I146 358   REFRIGRATN & SERV.
I147 3581  AUTO. MERCH. MACH.  I148 3582  COMM.LAUNDRY EQPMT
I149 3585  REFRIGRTN & HEATNG  I150 3586  MEASURING PUMPS
I151 3589  SERVICE IND. MACH.  I152 359   MISC.MACH,EXC.ELEC
I153 3592  CARBURETORS, ETC.   I154 3599  MACH,EXC.ELEC,NEC
I155 361   ELEC. DIST. EQUIP.  I156 362   ELEC. IND. APPARTS
I157 363   HOUSEHOLD APPLIANC  I158 364   ELEC.LIGHTNG, WRNG
I159 365   RADIO, TV RECEIVNG  I160 366   COMMUNICATION EQPT
I161 367   ELECTR. COMPONENTS  I162 3671  ELECTRON TUBES,REC
I163 3672  CATHODE RAY TUBES   I164 3673  ELECTRON TUBES,TRN
I165 3674  SEMICONDUCTORS,ETC  I166 3675  CAPACITORS
I167 3676  RESISTORS           I168 3677  COILS, TRANSFORMRS
I169 3678  ELECTR. CONNECTORS  I170 3679  ELECTR. COMP.,NEC
I171 369   MISC.ELEC.EQUIPMNT  I172 371   MOTOR VEHICLES,ETC
I173 3711  VEHICLES, CAR BODY  I174 3713  TRUCK, BUS BODIES
I175 3714  MOTOR VEHICLE PRTS  I176 3715  TRUCK TRAILERS
I177 372   AIRCRAFT & PARTS    I178 3721  AIRCRAFT
I179 3724  AIRCRAFT ENGINES    I180 3728  AIRCRAFT EQUIPMENT
I181 373   SHIP, BOAT BLDNG    I182 374   RAILROAD EQUIPMENT
I183 375   MOTORCYCLES, ETC.   I184 376   MISSILES, SPACE
I185 379   MISC.TRANSP.EQPMNT  I186 381   ENG.,SCIENCE INSTR
I187 382   MEASURNG,CNTRL DEV  I188 383   OPTICAL INSTRUMNTS
I189 384   MEDICAL INSTRUMNTS  I190 385   OPTHALMIC GOODS
I191 386   PHOTOGRPHC EQUIPMT  I192 387   WATCHES, CLOCKS
I193 391   JEWLERY,SILVERWARE  I194 393   MUSICAL INSTRUMNTS
I195 394   TOYS, SPORTING GDS  I196 395   PENS,PENCILS,ETC.
I197 396   COSTUME JEWELRY     I198 399   MISC. MANUFACTURES
ENDD
1INDANAVE
I001   81.0      I002   477.8      I003   901.7
I004   755.8     I005   371.5      I006   371.8
I007   197.5     I008   81.0       I009   81.0
I010   140.0     I011   163.9      I012   81.0
I013   81.0      I014   338.0      I015   2681.3
I016   602.1     I017   958.9      I018   81.0
I019   250.0     I020   250.0      I021   250.0
I022   250.0     I023   263.8      I024   322.7
I025   245.9     I026   263.8      I027   159.76
I028   1076.3    I029   980.1      I030   51.2
I031   41.1      I032   63.5       I033   88.4
I034   2384.7    I035   50.3       I036   72.3
I037   72.3      I038   72.3       I039   59.5
I040   77.6      I041   109.1      I042   59.5
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I043	59.5	I044	8303.7	I045	2194.2
I046	5827.4	I047	32.4	I048	56.5
I049	593.8	I050	37.9	I051	65.10
I052	76.6	I053	80.2	I054	292.2
I055	1200.0	I056	459.4	I057	447.8
I058	23.6	I059	1796.0	I060	1796.0
I061	1796.0	I062	1796.0	I063	65.10
I064	65.10	I065	61.2	I066	559.1
I067	1217.7	I068	264.7	I069	78.3
I070	264.7	I071	264.7	I072	291.1
I073	72.1	I074	23.3	I075	23.3
I076	23.3	I077	23.3	I078	23.3
I079	23.3	I080	23.3	I081	375.1
I082	332.4	I083	38.3	I084	38.3
I085	38.3	I086	210.7	I087	38.3
I088	652.3	I089	50.4	I090	48.80
I091	537.0	I092	365.3	I093	435.9
I094	467.8	I095	982.5	I096	48.80
I097	1077.5	I098	608.8	I099	608.8
I100	311.3	I101	434.1	I102	684.9
I103	48.8	I104	158.1	I105	913.2
I106	723.7	I107	231.7	I108	706.1
I109	29.9	I110	256.1	I111	373.6
I112	378.9	I113	202.9	I114	256.1
I115	256.1	I116	256.1	I117	48.9
I118	33.1	I119	525.1	I120	1009.4
I121	150.7	I122	168.4	I123	168.4
I124	535.0	I125	46.2	I126	34.3
I127	40.1	I128	1281.5	I129	103.4
I130	113.5	I131	113.5	I132	79.7
I133	113.5	I134	113.5	I135	113.5
I136	113.5	I137	325.3	I138	250.3
I139	40.1	I140	108.1	I141	108.1
I142	108.1	I143	108.1	I144	108.1
I145	108.1	I146	45.1	I147	119.1
I148	119.1	I149	374.2	I150	182.6
I151	119.12	I152	34.8	I153	186.18
I154	99.62	I155	31.5	I156	39.9
I157	33.8	I158	26.4	I159	26.6
I160	22.1	I161	69.50	I162	294.5
I163	228.4	I164	228.4	I165	239.5
I166	115.1	I167	168.59	I168	228.4
I169	127.9	I170	241.6	I171	34.8
I172	51.2	I173	280.86	I174	280.86
I175	320.4	I176	299.9	I177	24.5
I178	151.6	I179	151.6	I180	151.6
I181	151.6	I182	294.9	I183	456.6
I184	140.9	I185	234.8	I186	45.7
I187	20.6	I188	122.1	I189	28.1
I190	38.3	I191	122.1	I192	122.1
I193	12.8	I194	203.8	I195	109.3
I196	222.1	I197	12.8	I198	12.80

ENDD

1INDMXDAY

I001	81.0	I002	477.8	I003	901.7
I004	755.8	I005	371.5	I006	371.8
I007	197.5	I008	81.0	I009	81.0
I010	140.0	I011	163.9	I012	81.0
I013	81.0	I014	338.0	I015	2681.3

I016	602.1	I017	958.9	I018	81.0
I019	250.0	I020	250.0	I021	250.0
I022	250.0	I023	263.8	I024	322.7
I025	245.9	I026	263.8	I027	159.76
I028	1076.3	I029	980.1	I030	51.2
I031	41.1	I032	63.5	I033	88.4
I034	2384.7	I035	50.3	I036	72.3
I037	72.3	I038	72.3	I039	59.5
I040	77.6	I041	109.1	I042	59.5
I043	59.5	I044	8303.7	I045	2194.2
I046	5827.4	I047	32.4	I048	56.5
I049	593.8	I050	37.9	I051	65.10
I052	76.6	I053	80.2	I054	292.2
I055	1200.0	I056	459.4	I057	447.8
I058	23.6	I059	1796.0	I060	1796.0
I061	1796.0	I062	1796.0	I063	65.10
I064	65.10	I065	61.2	I066	559.1
I067	1217.7	I068	264.7	I069	78.3
I070	264.7	I071	264.7	I072	291.1
I073	72.1	I074	23.3	I075	23.3
I076	23.3	I077	23.3	I078	23.3
I079	23.3	I080	23.3	I081	375.1
I082	332.4	I083	38.3	I084	38.3
I085	38.3	I086	210.7	I087	38.3
I088	652.3	I089	50.4	I090	48.80
I091	537.0	I092	365.3	I093	435.9
I094	467.8	I095	982.5	I096	48.80
I097	1077.5	I098	608.8	I099	608.8
I100	311.3	I101	434.1	I102	684.9
I103	48.8	I104	158.1	I105	913.2
I106	723.7	I107	231.7	I108	706.1
I109	29.9	I110	256.1	I111	373.6
I112	378.9	I113	202.9	I114	256.1
I115	256.1	I116	256.1	I117	48.9
I118	33.1	I119	525.1	I120	1009.4
I121	150.7	I122	168.4	I123	168.4
I124	535.0	I125	46.2	I126	34.3
I127	40.1	I128	1281.5	I129	103.4
I130	113.5	I131	113.5	I132	79.7
I133	113.5	I134	113.5	I135	113.5
I136	113.5	I137	325.3	I138	250.3
I139	40.1	I140	108.1	I141	108.1
I142	108.1	I143	108.1	I144	108.1
I145	108.1	I146	45.1	I147	119.1
I148	119.1	I149	374.2	I150	182.6
I151	119.12	I152	34.8	I153	186.18
I154	99.62	I155	31.5	I156	39.9
I157	33.8	I158	26.4	I159	26.6
I160	22.1	I161	69.50	I162	294.5
I163	228.4	I164	228.4	I165	239.5
I166	115.1	I167	168.59	I168	228.4
I169	127.9	I170	241.6	I171	34.8
I172	51.2	I173	280.86	I174	280.86
I175	320.4	I176	299.9	I177	24.5
I178	151.6	I179	151.6	I180	151.6
I181	151.6	I182	294.9	I183	456.6
I184	140.9	I185	234.8	I186	45.7
I187	20.6	I188	122.1	I189	28.1
I190	38.3	I191	122.1	I192	122.1

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 I193   12.8          I194   203.8          I195   109.3
 I196   222.1         I197   12.8           I198   12.80
 ENDD
1ELASTCTY          COMMERCIAL AND INDUSTRIAL PRICE ELASTICITY
 CLAS -0.80           ILAS -0.65
 ENDD
1PUBCOFAA
 LOSS 0.00            FSER 0.0             FLSS 0.11
 ENDD
1PUBCOFMD
 LOSS 0.00            FSER 0.0             FLSS 0.11
 ENDD
1PUBLABEL
 LOSS LOSS (PER CAP.)  FSER FREE SERVICE     FLSS LOSS (PERCENT)
 ENDD
 ENDI
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EXHIBIT A-3 OUTPUT REPORTS REPORT NO. 1980- 2

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA CURRENT WATER USE FOR YEAR - 1980

RESIDENTIAL SECTOR

FLAT RATE-SEWERED AREAS

VALUE RANGE ($1000) (1980 VALUE)	UNITS (#)	UNRESTRICTED USE (GAL/DAY/UNIT)			RESTRICTED USE (GAL/DAY/UNIT)		
		WINTER	SUMMER	ANNUAL	WINTER	SUMMER	ANNUAL
.0 - 10.0	1693.	112.	258.	185.	106.	248.	177.
10.0 - 15.0	2334.	147.	447.	297.	140.	429.	284.
15.0 - 20.0	2515.	155.	545.	350.	147.	524.	335.
20.0 - 25.5	1313.	156.	636.	396.	149.	611.	380.
25.5 - 30.0	1256.	153.	714.	433.	146.	686.	416.
30.0 - 35.0	452.	153.	787.	470.	145.	757.	451.
35.0 - 40.0	206.	165.	874.	520.	157.	841.	499.
40.0 - 51.0	413.	214.	1039.	626.	204.	999.	601.
51.0 - 100.0	2.	282.	1509.	896.	269.	1452.	860.
TOTAL UNITS	10184.						
AVERAGE DAY PER UNIT		148.	545.	347.	141.	524.	332.
MAXIMUM DAY PER UNIT			1262.	1262.		1199.	1199.

- PERCENTAGE REDUCTIONS -

AVERAGE DAY				4.8	3.9	4.1
MAXIMUM DAY					5.0	5.0

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA CURRENT WATER USE FOR YEAR - 1980

RESIDENTIAL SECTOR

MASTER-METERED APARTMENTS

VALUE RANGE ($1000) (1980 VALUE)	UNITS (#)	UNRESTRICTED USE (GAL/DAY/UNIT)			RESTRICTED USE (GAL/DAY/UNIT)		
		WINTER	SUMMER	ANNUAL	WINTER	SUMMER	ANNUAL
.0 - 10.0	8336.	112.	160.	136.	106.	153.	130.
10.0 - 15.0	5954.	147.	210.	178.	140.	201.	170.
15.0 - 20.0	7627.	155.	222.	188.	147.	212.	179.
20.0 - 25.5	6540.	156.	224.	190.	149.	214.	182.
25.5 - 30.0	5792.	153.	220.	186.	146.	210.	178.
30.0 - 35.0	1182.	153.	219.	186.	145.	209.	177.
35.0 - 40.0	1151.	165.	236.	201.	157.	226.	191.
40.0 - 51.0	271.	214.	306.	260.	204.	293.	248.
51.0 - 100.0	183.	253.	363.	308.	241.	347.	294.
TOTAL UNITS	37036.						
AVERAGE DAY PER UNIT		145.	208.	176.	138.	199.	168.
MAXIMUM DAY PER UNIT			208.	208.		198.	198.
- PERCENTAGE REDUCTIONS -							
AVERAGE DAY					4.8	4.4	4.6
MAXIMUM DAY						4.9	4.9

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA CURRENT WATER USE FOR YEAR - 1980

RESIDENTIAL SECTOR

METERED-SEWERED AREAS

VALUE RANGE ($1000) (1980 VALUE)	UNITS (#)	UNRESTRICTED USE (GAL/DAY/UNIT)			RESTRICTED USE (GAL/DAY/UNIT)		
		WINTER	SUMMER	ANNUAL	WINTER	SUMMER	ANNUAL
.0 - 10.0	4496.	200.	412.	306.	192.	396.	294.
10.0 - 15.0	5543.	209.	524.	366.	200.	503.	352.
15.0 - 20.0	8276.	216.	579.	397.	207.	557.	382.
20.0 - 25.5	10588.	222.	580.	401.	213.	558.	386.
25.5 - 30.0	10321.	228.	619.	424.	219.	595.	407.
30.0 - 35.0	11034.	236.	653.	444.	226.	628.	427.
35.0 - 40.0	8717.	243.	687.	465.	233.	660.	447.
40.0 - 50.1	13654.	254.	734.	494.	243.	706.	474.
51.0 - 60.0	7848.	269.	737.	503.	258.	708.	483.
60.0 - 80.0	8015.	287.	804.	546.	276.	773.	524.
80.0 - 100.0	3379.	318.	893.	605.	305.	859.	582.
100.0 - 400.0	3011.	556.	1294.	925.	533.	1244.	888.
TOTAL UNITS	94882.						
AVERAGE DAY PER UNIT		252.	679.	465.	242.	653.	447.
MAXIMUM DAY PER UNIT			1023.	1023.		978.	978.
- PERCENTAGE REDUCTIONS -							
AVERAGE DAY					4.1	3.9	3.9
MAXIMUM DAY						4.4	4.4

REPORT NO. 1980- 5

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STUDY AREA - ARIDWEST USA CURRENT WATER USE FOR YEAR - 1980

RESIDENTIAL SECTOR

SUMMARY

CATEGORY	UNITS (#)	UNRESTRICTED USE (1000 G/D)			RESTRICTED USE (1000 G/D)		
		WINTER	SUMMER	ANNUAL	WINTER	SUMMER	ANNUAL
- AVERAGE DAY -							
FLAT RATE/SWR	10184.	1510.	5550.	3530.	1438.	5333.	3385.
APARTMENTS	37036.	5370.	7695.	6532.	5112.	7355.	6234.
METERED/SEWRD	94882.	23895.	64433.	44164.	22917.	61945.	42431.
TOTALS	142102.	30775.	77678.	54226.	29467.	74633.	52050.
- MAXIMUM DAY -							
RESIDENTIAL SECTOR			117582.	117582.		112300.	112300.
- PERCENTAGE REDUCTIONS -							
AVERAGE DAY					4.3	3.9	4.0
MAXIMUM DAY						4.5	4.5

SUMMER EVAPOTRANSPIRATION (INCHES) = 18.24

SUMMER PRECIPITATION (INCHES) = 3.74

MAX. DAY EVAPOTRANSPIRATION (INCHES) = .29

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA CURRENT WATER USE FOR YEAR - 1980

COMMERCIAL/INSTITUTIONAL SECTOR

CATEGORY	TYPE OF UNIT	UNITS (#)	UNRESTRICTED USE (1000 G/D)		
			WINTER	SUMMER	ANNUAL
MISC. COMMERCIAL	EMPLOYEES	30301.	2924.0	2924.0	2924.0
VOC. SCHOOLS	EMPLOYEES	1079.	82.5	82.5	82.5
MISC. RETAIL	EMPLOYEES	12667.	337.3	337.3	337.3
BOARDING HOUSES	EMPLOYEES	48.	4.9	4.9	4.9
TRANSP. TERMINAL	EMPLOYEES	154.	28.9	28.9	28.9
BARBER, CLEANING	EMPLOYEES	1016.	1038.4	1038.4	1038.4
LANDSCAPING	EMPLOYEES	274.	29.2	29.2	29.2
MISC. WHOLESALE	EMPLOYEES	18368.	736.6	736.6	736.6
RECREATION FACL.	EMPLOYEES	292.	243.1	243.1	243.1
FOOD AUTO RETAIL	EMPLOYEES	9264.	1214.5	1214.5	1214.5
DANCE STUDIOS	EMPLOYEES	18.	1.3	1.3	1.3
HOTELS, RESTRNTS	EMPLOYEES	9118.	4507.0	4507.0	4507.0
ELEC, GAS UTIL.	EMPLOYEES	3585.	390.0	390.0	390.0
PUBLIC ADMINIST.	EMPLOYEES	56319.	7051.1	7051.1	7051.1
SCHOOLS, UNIV.	EMPLOYEES	10438.	3138.7	3138.7	3138.7
LABS, WTR UTIL.	EMPLOYEES	2259.	1000.4	1000.4	1000.4
HEALTH SERVICES	EMPLOYEES	610.	76.4	76.4	76.4
MED. OFF. BAKERS	EMPLOYEES	1664.	180.5	180.5	180.5
NURSING FACIL.	EMPLOYEES	489.	150.5	150.5	150.5
HOSPITALS	EMPLOYEES	3855.	787.8	787.8	787.8
TOTAL SECTOR EMPLOYMENT		161818.			
AVERAGE DAY			23923.4	23923.4	23923.4
MAXIMUM DAY				23923.4	23923.4

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA CURRENT WATER USE FOR YEAR - 1980

COMMERCIAL/INSTITUTIONAL SECTOR

CATEGORY	TYPE OF UNIT	UNITS (#)	RESTRICTED USE (1000 G/D) WINTER	SUMMER	ANNUAL
MISC. COMMERCIAL	EMPLOYEES	30301.	2924.0	2924.0	2924.0
VOC. SCHOOLS	EMPLOYEES	1079.	82.5	82.5	82.5
MISC. RETAIL	EMPLOYEES	12667.	337.3	337.3	337.3
BOARDING HOUSES	EMPLOYEES	48.	4.9	4.9	4.9
TRANSP. TERMINAL	EMPLOYEES	154.	28.9	28.9	28.9
BARBER, CLEANING	EMPLOYEES	1016.	1038.4	1038.4	1038.4
LANDSCAPING	EMPLOYEES	274.	29.2	29.2	29.2
MISC. WHOLESALE	EMPLOYEES	18368.	736.6	736.6	736.6
RECREATION FACL.	EMPLOYEES	292.	243.1	243.1	243.1
FOOD AUTO RETAIL	EMPLOYEES	9264.	1214.5	1214.5	1214.5
DANCE STUDIOS	EMPLOYEES	18.	1.3	1.3	1.3
HOTELS, RESTRNTS	EMPLOYEES	9118.	4507.0	4507.0	4507.0
ELEC, GAS UTIL.	EMPLOYEES	3585.	390.0	390.0	390.0
PUBLIC ADMINIST.	EMPLOYEES	56319.	7051.1	7051.1	7051.1
SCHOOLS, UNIV.	EMPLOYEES	10438.	3138.7	3138.7	3138.7
LABS, WTR UTIL.	EMPLOYEES	2259.	1000.4	1000.4	1000.4
HEALTH SERVICES	EMPLOYEES	610.	76.4	76.4	76.4
MED. OFF. BAKERS	EMPLOYEES	1664.	180.5	180.5	180.5
NURSING FACIL.	EMPLOYEES	489.	150.5	150.5	150.5
HOSPITALS	EMPLOYEES	3855.	787.8	787.8	787.8
TOTAL SECTOR EMPLOYMENT		161818.			
AVERAGE DAY			23923.4	23923.4	23923.4
MAXIMUM DAY				23923.4	23923.4
- PERCENTAGE REDUCTIONS -					
AVERAGE DAY			.0	.0	.0
MAXIMUM DAY				.0	.0

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA CURRENT WATER USE FOR YEAR - 1980

INDUSTRIAL SECTOR

SIC CODE	CATEGORY	TYPE OF UNIT	UNITS (#)	UNRESTRICTED USE (1000 G/D)		
				WINTER	SUMMER	ANNUAL
201	MEAT PRODUCTS	EMPLOYEES	282.	22.8	22.8	22.8
202	DAIRY PRODUCTS	EMPLOYEES	316.	117.5	117.5	117.5
203	PRSRVD FRUITS, VEG	EMPLOYEES	679.	134.1	134.1	134.1
204	GRAIN MILL PRDCTS	EMPLOYEES	365.	29.6	29.6	29.6
205	BAKERY PRODUCTS	EMPLOYEES	291.	23.6	23.6	23.6
206	SUGAR & CONFECTNRY	EMPLOYEES	37.	3.0	3.0	3.0
207	FATS & OILS	EMPLOYEES	56.	4.5	4.5	4.5
208	BEVERAGES	EMPLOYEES	306.	103.4	103.4	103.4
209	MISC. FOODS, ETC.	EMPLOYEES	281.	22.8	22.8	22.8
225	KNITTING MILLS	EMPLOYEES	11.	1.8	1.8	1.8
228	YARN & THREAD MLLS	EMPLOYEES	2.	.1	.1	.1
229	MISC. TEXTILE MLLS	EMPLOYEES	54.	2.2	2.2	2.2
230	APPAREL, ETC.	EMPLOYEES	14962.	950.1	950.1	950.1
243	MILLWORK, PLYWOOD	EMPLOYEES	734.	36.9	36.9	36.9
244	WOOD CONTAINERS	EMPLOYEES	13.	.9	.9	.9
245	WOOD BUILDINGS ETC	EMPLOYEES	26.	1.9	1.9	1.9
249	MISC. WOOD PRODCTS	EMPLOYEES	38.	2.7	2.7	2.7
251	HOUSEHOLD FRNITURE	EMPLOYEES	86.	5.1	5.1	5.1
254	PARTITIONS, FIXTRS	EMPLOYEES	24.	1.4	1.4	1.4
259	MISC. FURNITURE	EMPLOYEES	10.	.6	.6	.6
264	MISC. CONV. PAPER	EMPLOYEES	675.	21.9	21.9	21.9
265	PAPERBOARD CONTNRS	EMPLOYEES	307.	17.3	17.3	17.3
270	PRINTING, PUBLSHNG	EMPLOYEES	1629.	61.7	61.7	61.7
281	IND. ORGANIC CHEM.	EMPLOYEES	2.	.1	.1	.1
282	PLASTICS, SYNTHTCS	EMPLOYEES	11.	.8	.8	.8
283	DRUGS	EMPLOYEES	14.	1.1	1.1	1.1
285	PAINTS & ALLIED PR	EMPLOYEES	100.	2.4	2.4	2.4
287	AGRICULTURAL CHEM.	EMPLOYEES	16.	1.0	1.0	1.0
289	MISC. CHEM. PRDCTS	EMPLOYEES	4.	.3	.3	.3
291	PETROLEUM REFINING	EMPLOYEES	164.	10.0	10.0	10.0
306	FABRIC.RUBBER, NEC	EMPLOYEES	242.	70.4	70.4	70.4
307	MISC. PLASTICS PRD	EMPLOYEES	341.	24.6	24.6	24.6
313	BOOT, SHOE STOCK	EMPLOYEES	111.	2.6	2.6	2.6
314	FOOTWEAR, EX. RUBR	EMPLOYEES	2200.	51.3	51.3	51.3
315	LEATHER GLOVES	EMPLOYEES	47.	1.1	1.1	1.1
319	LEATHER GOODS, NEC	EMPLOYEES	7.	.2	.2	.2
323	PURCHASD GLASS PRD	EMPLOYEES	5.	.2	.2	.2
324	HYDRAULIC CEMENT	EMPLOYEES	157.	6.0	6.0	6.0
325	STRUCTURL CLAY PRD	EMPLOYEES	10.	.4	.4	.4
327	CONCRETE, GYPSUM	EMPLOYEES	616.	23.6	23.6	23.6

329	MISC.NONMET.MINERL	EMPLOYEES	101.	5.1	5.1	5.1
331	BLAST FURNC & STEL	EMPLOYEES	508.	24.8	24.8	24.8
332	IRON, STEEL FOUNDR	EMPLOYEES	96.	4.7	4.7	4.7
333	PRIMARY NONFERROUS	EMPLOYEES	1420.	616.4	616.4	616.4
335	NONFERROUS ROLLING	EMPLOYEES	255.	12.4	12.4	12.4
336	NONFERROUS FOUNDRY	EMPLOYEES	238.	37.6	37.6	37.6
344	STRUCTRL STEEL PRD	EMPLOYEES	843.	25.2	25.2	25.2
345	SCREW MACHNE PRODS	EMPLOYEES	10.	.5	.5	.5
346	METAL FORGINGS,ETC	EMPLOYEES	9.	.3	.3	.3
347	METAL SERVICES,NEC	EMPLOYEES	79.	42.3	42.3	42.3
348	ORDNANCE & ACCESS.	EMPLOYEES	41.	1.9	1.9	1.9
349	MISC. FAB. METAL	EMPLOYEES	12.	.4	.4	.4
351	ENGINES & TURBINES	EMPLOYEES	40.	1.6	1.6	1.6
354	METALWORKING MACH.	EMPLOYEES	129.	42.0	42.0	42.0
356	GENERAL IND. MACH.	EMPLOYEES	376.	15.1	15.1	15.1
358	REFRIGRATN & SERV.	EMPLOYEES	183.	8.3	8.3	8.3
359	MISC.MACH,EXC.ELEC	EMPLOYEES	187.	6.5	6.5	6.5
361	ELEC. DIST. EQUIP.	EMPLOYEES	202.	6.4	6.4	6.4
362	ELEC. IND. APPARTS	EMPLOYEES	135.	5.4	5.4	5.4
363	HOUSEHOLD APPLIANC	EMPLOYEES	100.	3.4	3.4	3.4
364	ELEC.LIGHTNG, WRNG	EMPLOYEES	95.	2.5	2.5	2.5
365	RADIO, TV RECEIVNG	EMPLOYEES	236.	6.3	6.3	6.3
366	COMMUNICATION EQPT	EMPLOYEES	1228.	27.1	27.1	27.1
367	ELECTR. COMPONENTS	EMPLOYEES	1605.	111.5	111.5	111.5
369	MISC.ELEC.EQUIPMNT	EMPLOYEES	355.	12.4	12.4	12.4
371	MOTOR VEHICLES,ETC	EMPLOYEES	491.	25.1	25.1	25.1
372	AIRCRAFT & PARTS	EMPLOYEES	11.	.3	.3	.3
381	ENG.,SCIENCE INSTR	EMPLOYEES	1.	.0	.0	.0
382	MEASURNG,CNTRL DEV	EMPLOYEES	359.	7.4	7.4	7.4
384	MEDICAL INSTRUMNTS	EMPLOYEES	16.	.4	.4	.4
385	OPTHALMIC GOODS	EMPLOYEES	113.	4.3	4.3	4.3
391	JEWLERY,SILVERWARE	EMPLOYEES	31.	.4	.4	.4
394	TOYS, SPORTING GDS	EMPLOYEES	1068.	116.7	116.7	116.7
396	COSTUME JEWELRY	EMPLOYEES	75.	1.0	1.0	1.0
399	MISC. MANUFACTURES	EMPLOYEES	66.	.8	.8	.8
	TOTAL SECTOR EMPLOYMENT		35945.			
	AVERAGE DAY			2938.7	2938.7	2938.7
	MAXIMUM DAY				2938.7	2938.7

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA CURRENT WATER USE FOR YEAR - 1980

INDUSTRIAL SECTOR

SIC CODE	CATEGORY	TYPE OF UNIT	UNITS (#)	RESTRICTED USE (1000 G/D)		
				WINTER	SUMMER	ANNUAL
201	MEAT PRODUCTS	EMPLOYEES	282.	22.8	22.8	22.8
202	DAIRY PRODUCTS	EMPLOYEES	316.	117.5	117.5	117.5
203	PRSRVD FRUITS, VEG	EMPLOYEES	679.	134.1	134.1	134.1
204	GRAIN MILL PRDCTS	EMPLOYEES	365.	29.6	29.6	29.6
205	BAKERY PRODUCTS	EMPLOYEES	291.	23.6	23.6	23.6
206	SUGAR & CONFECTNRY	EMPLOYEES	37.	3.0	3.0	3.0
207	FATS & OILS	EMPLOYEES	56.	4.5	4.5	4.5
208	BEVERAGES	EMPLOYEES	306.	103.4	103.4	103.4
209	MISC. FOODS, ETC.	EMPLOYEES	281.	22.8	22.8	22.8
225	KNITTING MILLS	EMPLOYEES	11.	1.8	1.8	1.8
228	YARN & THREAD MLLS	EMPLOYEES	2.	.1	.1	.1
229	MISC. TEXTILE MLLS	EMPLOYEES	54.	2.2	2.2	2.2
230	APPAREL, ETC.	EMPLOYEES	14962.	950.1	950.1	950.1
243	MILLWORK, PLYWOOD	EMPLOYEES	734.	36.9	36.9	36.9
244	WOOD CONTAINERS	EMPLOYEES	13.	.9	.9	.9
245	WOOD BUILDINGS ETC	EMPLOYEES	26.	1.9	1.9	1.9
249	MISC. WOOD PRODCTS	EMPLOYEES	38.	2.7	2.7	2.7
251	HOUSEHOLD FRNITURE	EMPLOYEES	86.	5.1	5.1	5.1
254	PARTITIONS, FIXTRS	EMPLOYEES	24.	1.4	1.4	1.4
259	MISC. FURNITURE	EMPLOYEES	10.	.6	.6	.6
264	MISC. CONV. PAPER	EMPLOYEES	675.	21.9	21.9	21.9
265	PAPERBOARD CONTNRS	EMPLOYEES	307.	17.3	17.3	17.3
270	PRINTING, PUBLSHNG	EMPLOYEES	1629.	61.7	61.7	61.7
281	IND. ORGANIC CHEM.	EMPLOYEES	2.	.1	.1	.1
282	PLASTICS, SYNTHTCS	EMPLOYEES	11.	.8	.8	.8
283	DRUGS	EMPLOYEES	14.	1.1	1.1	1.1
285	PAINTS & ALLIED PR	EMPLOYEES	100.	2.4	2.4	2.4
287	AGRICULTURAL CHEM.	EMPLOYEES	16.	1.0	1.0	1.0
289	MISC. CHEM. PRDCTS	EMPLOYEES	4.	.3	.3	.3
291	PETROLEUM REFINING	EMPLOYEES	164.	10.0	10.0	10.0
306	FABRIC.RUBBER, NEC	EMPLOYEES	242.	70.4	70.4	70.4
307	MISC. PLASTICS PRD	EMPLOYEES	341.	24.6	24.6	24.6
313	BOOT, SHOE STOCK	EMPLOYEES	111.	2.6	2.6	2.6
314	FOOTWEAR, EX. RUBR	EMPLOYEES	2200.	51.3	51.3	51.3
315	LEATHER GLOVES	EMPLOYEES	47.	1.1	1.1	1.1
319	LEATHER GOODS, NEC	EMPLOYEES	7.	.2	.2	.2
323	PURCHASD GLASS PRD	EMPLOYEES	5.	.2	.2	.2
324	HYDRAULIC CEMENT	EMPLOYEES	157.	6.0	6.0	6.0
325	STRUCTURL CLAY PRD	EMPLOYEES	10.	.4	.4	.4
327	CONCRETE, GYPSUM	EMPLOYEES	616.	23.6	23.6	23.6

329	MISC.NONMET.MINERL	EMPLOYEES	101.	5.1	5.1	5.1
331	BLAST FURNC & STEL	EMPLOYEES	508.	24.8	24.8	24.8
332	IRON, STEEL FOUNDR	EMPLOYEES	96.	4.7	4.7	4.7
333	PRIMARY NONFERROUS	EMPLOYEES	1420.	616.4	616.4	616.4
335	NONFERROUS ROLLING	EMPLOYEES	255.	12.4	12.4	12.4
336	NONFERROUS FOUNDRY	EMPLOYEES	238.	37.6	37.6	37.6
344	STRUCTRL STEEL PRD	EMPLOYEES	843.	25.2	25.2	25.2
345	SCREW MACHNE PRODS	EMPLOYEES	10.	.5	.5	.5
346	METAL FORGINGS,ETC	EMPLOYEES	9.	.3	.3	.3
347	METAL SERVICES,NEC	EMPLOYEES	79.	42.3	42.3	42.3
348	ORDNANCE & ACCESS.	EMPLOYEES	41.	1.9	1.9	1.9
349	MISC. FAB. METAL	EMPLOYEES	12.	.4	.4	.4
351	ENGINES & TURBINES	EMPLOYEES	40.	1.6	1.6	1.6
354	METALWORKING MACH.	EMPLOYEES	129.	42.0	42.0	42.0
356	GENERAL IND. MACH.	EMPLOYEES	376.	15.1	15.1	15.1
358	REFRIGRATN & SERV.	EMPLOYEES	183.	8.3	8.3	8.3
359	MISC.MACH,EXC.ELEC	EMPLOYEES	187.	6.5	6.5	6.5
361	ELEC. DIST. EQUIP.	EMPLOYEES	202.	6.4	6.4	6.4
362	ELEC. IND. APPARTS	EMPLOYEES	135.	5.4	5.4	5.4
363	HOUSEHOLD APPLIANC	EMPLOYEES	100.	3.4	3.4	3.4
364	ELEC.LIGHTNG, WRNG	EMPLOYEES	95.	2.5	2.5	2.5
365	RADIO, TV RECEIVNG	EMPLOYEES	236.	6.3	6.3	6.3
366	COMMUNICATION EQPT	EMPLOYEES	1228.	27.1	27.1	27.1
367	ELECTR. COMPONENTS	EMPLOYEES	1605.	111.5	111.5	111.5
369	MISC.ELEC.EQUIPMNT	EMPLOYEES	355.	12.4	12.4	12.4
371	MOTOR VEHICLES,ETC	EMPLOYEES	491.	25.1	25.1	25.1
372	AIRCRAFT & PARTS	EMPLOYEES	11.	.3	.3	.3
381	ENG.,SCIENCE INSTR	EMPLOYEES	1.	.0	.0	.0
382	MEASURNG,CNTRL DEV	EMPLOYEES	359.	7.4	7.4	7.4
384	MEDICAL INSTRUMNTS	EMPLOYEES	16.	.4	.4	.4
385	OPTHALMIC GOODS	EMPLOYEES	113.	4.3	4.3	4.3
391	JEWLERY,SILVERWARE	EMPLOYEES	31.	.4	.4	.4
394	TOYS, SPORTING GDS	EMPLOYEES	1068.	116.7	116.7	116.7
396	COSTUME JEWELRY	EMPLOYEES	75.	1.0	1.0	1.0
399	MISC. MANUFACTURES	EMPLOYEES	66.	.8	.8	.8
	TOTAL SECTOR EMPLOYMENT		35945.			
	AVERAGE DAY			2938.7	2938.7	2938.7
	MAXIMUM DAY				2938.7	2938.7
- PERCENTAGE REDUCTIONS -						
	AVERAGE DAY			.0	.0	.0
	MAXIMUM DAY				.0	.0

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA CURRENT WATER USE FOR YEAR - 1980

PUBLIC/UNACCOUNTED SECTOR

CATEGORY	UNITS (#)	UNRESTRICTED USE (1000 G/D)		
		WINTER	SUMMER	ANNUAL
LOSS (PERCENT)	0.	10022.1	10022.1	10022.1
AVERAGE DAY		10022.1	10022.1	10022.1
MAXIMUM DAY			17852.6	17852.6

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA CURRENT WATER USE FOR YEAR - 1980

PUBLIC/UNACCOUNTED SECTOR

CATEGORY	UNITS (#)	RESTRICTED USE (1000 G/D)		
		WINTER	SUMMER	ANNUAL
LOSS (PERCENT)	0.	10022.1	10022.1	10022.1
AVERAGE DAY		10022.1	10022.1	10022.1
MAXIMUM DAY			17852.6	17852.6
- PERCENTAGE REDUCTIONS -				
AVERAGE DAY		.0	.0	.0
MAXIMUM DAY			.0	.0

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA CURRENT WATER USE FOR YEAR - 1980

MUNICIPAL SUMMARY

	UNRESTRICTED USE (1000 G/D)		RESTRICTED USE (1000 G/D)	
	ANNUAL AVERAGE	MAXIMUM DAY*	ANNUAL AVERAGE	MAXIMUM DAY*
RESIDENTIAL	54226.	117582.	52050.	112301.
COMMERCIAL/INSTL	23923.	23923.	23923.	23923.
INDUSTRIAL	2939.	2939.	2939.	2939.
PUBLIC/UNACCOUNTED	10022.	17853.	10022.	17853.
TOTAL MUNICIPAL	91110.	154466.	88934.	149185.

* NOTE: THE MAXIMUM DAY MUNICIPAL TOTAL IS THE SUM OF THE ANNUAL AVERAGE MUNICIPAL TOTAL AND THE LARGEST SECTORAL DIFFERENCE BETWEEN ANNUAL AND MAXIMUM DAY USE.

	PERCENTAGE REDUCTIONS	
	ANNUAL AVERAGE	MAXIMUM DAY
RESIDENTIAL	4.0	4.5
COMMERCIAL/INSTL	.0	.0
INDUSTRIAL	.0	.0
PUBLIC/UNACCOUNTED	.0	.0
TOTAL MUNICIPAL	2.4	3.4

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 1990

RESIDENTIAL SECTOR

FLAT RATE-SEWERED AREAS

VALUE RANGE ($1000) (1980 VALUE)	UNITS (#)	UNRESTRICTED USE (GAL/DAY/UNIT)			RESTRICTED USE (GAL/DAY/UNIT)		
		WINTER	SUMMER	ANNUAL	WINTER	SUMMER	ANNUAL
.0 - 10.0	824.	112.	258.	185.	105.	246.	176.
10.0 - 15.0	1137.	147.	447.	297.	138.	427.	282.
15.0 - 20.0	1225.	155.	545.	350.	146.	521.	333.
20.0 - 25.5	639.	156.	636.	396.	147.	608.	378.
25.5 - 30.0	4576.	153.	714.	433.	144.	683.	414.
30.0 - 35.0	1647.	153.	787.	470.	144.	753.	449.
35.0 - 40.0	751.	165.	874.	520.	155.	837.	496.
40.0 - 51.0	1505.	214.	1039.	626.	201.	995.	598.
51.0 - 100.0	12.	282.	1509.	896.	266.	1445.	856.
TOTAL UNITS	12315.						
AVERAGE DAY PER UNIT		158.	698.	428.	149.	668.	408.
MAXIMUM DAY PER UNIT			1536.	1536.		1439.	1439.
- PERCENTAGE REDUCTIONS -							
AVERAGE DAY					5.8	4.3	4.6
MAXIMUM DAY						6.3	6.3

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 1990

RESIDENTIAL SECTOR

MASTER-METERED APARTMENTS

VALUE RANGE ($1000) (1980 VALUE)	UNITS (#)	UNRESTRICTED USE (GAL/DAY/UNIT)			RESTRICTED USE (GAL/DAY/UNIT)		
		WINTER	SUMMER	ANNUAL	WINTER	SUMMER	ANNUAL
.0 - 10.0	4017.	112.	160.	136.	105.	152.	129.
10.0 - 15.0	2869.	147.	210.	178.	138.	199.	169.
15.0 - 20.0	3676.	155.	222.	188.	146.	210.	178.
20.0 - 25.5	3152.	156.	224.	190.	147.	213.	180.
25.5 - 30.0	20883.	153.	220.	186.	144.	208.	176.
30.0 - 35.0	4262.	153.	219.	186.	144.	208.	176.
35.0 - 40.0	4150.	165.	236.	201.	155.	224.	190.
40.0 - 51.0	977.	214.	306.	260.	201.	291.	246.
51.0 - 100.0	1048.	253.	363.	308.	239.	344.	292.
TOTAL UNITS	45033.						
AVERAGE DAY PER UNIT		154.	221.	188.	145.	209.	177.
MAXIMUM DAY PER UNIT			221.	221.		208.	208.

- PERCENTAGE REDUCTIONS -

AVERAGE DAY					5.8	5.2	5.4
MAXIMUM DAY						5.9	5.9

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 1990

RESIDENTIAL SECTOR

METERED-SEWERED AREAS

VALUE RANGE ($1000) (1980 VALUE)	UNITS (#)	UNRESTRICTED USE (GAL/DAY/UNIT)			RESTRICTED USE (GAL/DAY/UNIT)		
		WINTER	SUMMER	ANNUAL	WINTER	SUMMER	ANNUAL
.0 - 10.0	5746.	200.	412.	306.	191.	394.	293.
10.0 - 15.0	7084.	209.	524.	366.	199.	501.	350.
15.0 - 20.0	10576.	216.	579.	397.	206.	554.	380.
20.0 - 25.5	13531.	222.	580.	401.	212.	555.	384.
25.5 - 30.0	13553.	228.	619.	424.	218.	592.	405.
30.0 - 35.0	14489.	236.	653.	444.	225.	625.	425.
35.0 - 40.0	11446.	243.	687.	465.	232.	657.	444.
40.0 - 50.1	17929.	254.	734.	494.	242.	702.	472.
51.0 - 60.0	8448.	269.	737.	503.	257.	705.	481.
60.0 - 80.0	8627.	287.	804.	546.	274.	769.	522.
80.0 - 100.0	3637.	318.	893.	605.	303.	854.	579.
TOTAL UNITS	115065.						
AVERAGE DAY PER UNIT		240.	655.	448.	229.	626.	428.
MAXIMUM DAY PER UNIT			973.	973.		922.	922.
- PERCENTAGE REDUCTIONS -							
AVERAGE DAY					4.6	4.3	4.4
MAXIMUM DAY						5.3	5.3

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 1990

RESIDENTIAL SECTOR

SUMMARY

CATEGORY	UNITS (#)	UNRESTRICTED USE (1000 G/D)			RESTRICTED USE (1000 G/D)		
		WINTER	SUMMER	ANNUAL	WINTER	SUMMER	ANNUAL
- AVERAGE DAY -							
FLAT RATE/SWR	12315.	1950.	8592.	5271.	1837.	8223.	5030.
APARTMENTS	45033.	6942.	9947.	8444.	6539.	9433.	7986.
METERED/SEWRD	115065.	27661.	75332.	51497.	26385.	72060.	49222.
TOTALS	172413.	36553.	93871.	65212.	34761.	89716.	62238.
- MAXIMUM DAY -							
RESIDENTIAL SECTOR			140789.	140789.		133123.	133123.
- PERCENTAGE REDUCTIONS -							
AVERAGE DAY					4.9	4.4	4.6
MAXIMUM DAY						5.4	5.4

SUMMER EVAPOTRANSPIRATION (INCHES) = 18.24

SUMMER PRECIPITATION (INCHES) = 3.74

MAX. DAY EVAPOTRANSPIRATION (INCHES) = .29

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 1990

COMMERCIAL/INSTITUTIONAL SECTOR

CATEGORY	TYPE OF UNIT	UNITS (#)	UNRESTRICTED USE (1000 G/D)		
			WINTER	SUMMER	ANNUAL
MISC. COMMERCIAL	EMPLOYEES	33301.	3213.6	3213.6	3213.6
VOC. SCHOOLS	EMPLOYEES	1145.	87.6	87.6	87.6
MISC. RETAIL	EMPLOYEES	14363.	382.5	382.5	382.5
BOARDING HOUSES	EMPLOYEES	51.	5.2	5.2	5.2
TRANSP. TERMINAL	EMPLOYEES	153.	28.8	28.8	28.8
BARBER, CLEANING	EMPLOYEES	1078.	1101.8	1101.8	1101.8
LANDSCAPING	EMPLOYEES	423.	45.2	45.2	45.2
MISC. WHOLESALE	EMPLOYEES	18371.	736.7	736.7	736.7
RECREATION FACL.	EMPLOYEES	310.	258.0	258.0	258.0
FOOD AUTO RETAIL	EMPLOYEES	10504.	1377.1	1377.1	1377.1
DANCE STUDIOS	EMPLOYEES	19.	1.3	1.3	1.3
HOTELS, RESTRNTS	EMPLOYEES	9675.	4782.6	4782.6	4782.6
ELEC, GAS UTIL.	EMPLOYEES	3568.	388.2	388.2	388.2
PUBLIC ADMINIST.	EMPLOYEES	63353.	7931.7	7931.7	7931.7
SCHOOLS, UNIV.	EMPLOYEES	11076.	3330.6	3330.6	3330.6
LABS, WTR UTIL.	EMPLOYEES	2397.	1061.6	1061.6	1061.6
HEALTH SERVICES	EMPLOYEES	647.	81.1	81.1	81.1
MED. OFF. BAKERS	EMPLOYEES	1766.	191.6	191.6	191.6
NURSING FACIL.	EMPLOYEES	519.	159.7	159.7	159.7
HOSPITALS	EMPLOYEES	4091.	836.0	836.0	836.0
TOTAL SECTOR EMPLOYMENT		176811.			
AVERAGE DAY			26000.8	26000.8	26000.8
MAXIMUM DAY				26000.8	26000.8

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 1990

COMMERCIAL/INSTITUTIONAL SECTOR

CATEGORY	TYPE OF UNIT	UNITS (#)	RESTRICTED USE (1000 G/D)		
			WINTER	SUMMER	ANNUAL
MISC. COMMERCIAL	EMPLOYEES	33301.	3213.6	3213.6	3213.6
VOC. SCHOOLS	EMPLOYEES	1145.	87.6	87.6	87.6
MISC. RETAIL	EMPLOYEES	14363.	382.5	382.5	382.5
BOARDING HOUSES	EMPLOYEES	51.	5.2	5.2	5.2
TRANSP. TERMINAL	EMPLOYEES	153.	28.8	28.8	28.8
BARBER, CLEANING	EMPLOYEES	1078.	1101.8	1101.8	1101.8
LANDSCAPING	EMPLOYEES	423.	45.2	45.2	45.2
MISC. WHOLESALE	EMPLOYEES	18371.	736.7	736.7	736.7
RECREATION FACL.	EMPLOYEES	310.	258.0	258.0	258.0
FOOD AUTO RETAIL	EMPLOYEES	10504.	1377.1	1377.1	1377.1
DANCE STUDIOS	EMPLOYEES	19.	1.3	1.3	1.3
HOTELS, RESTRNTS	EMPLOYEES	9675.	4782.6	4782.6	4782.6
ELEC, GAS UTIL.	EMPLOYEES	3568.	388.2	388.2	388.2
PUBLIC ADMINIST.	EMPLOYEES	63353.	7931.7	7931.7	7931.7
SCHOOLS, UNIV.	EMPLOYEES	11076.	3330.6	3330.6	3330.6
LABS, WTR UTIL.	EMPLOYEES	2397.	1061.6	1061.6	1061.6
HEALTH SERVICES	EMPLOYEES	647.	81.1	81.1	81.1
MED. OFF. BAKERS	EMPLOYEES	1766.	191.6	191.6	191.6
NURSING FACIL.	EMPLOYEES	519.	159.7	159.7	159.7
HOSPITALS	EMPLOYEES	4091.	836.0	836.0	836.0
TOTAL SECTOR EMPLOYMENT		176811.			
AVERAGE DAY			26000.8	26000.8	26000.8
MAXIMUM DAY				26000.8	26000.8
- PERCENTAGE REDUCTIONS -					
AVERAGE DAY			.0	.0	.0
MAXIMUM DAY				.0	.0

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 1990

INDUSTRIAL SECTOR

SIC CODE	CATEGORY	TYPE OF UNIT	UNITS (#)	UNRESTRICTED USE (1000 G/D)		
				WINTER	SUMMER	ANNUAL
201	MEAT PRODUCTS	EMPLOYEES	248.	20.1	20.1	20.1
202	DAIRY PRODUCTS	EMPLOYEES	278.	103.3	103.3	103.3
203	PRSRVD FRUITS, VEG	EMPLOYEES	860.	169.9	169.9	169.9
204	GRAIN MILL PRDCTS	EMPLOYEES	462.	37.4	37.4	37.4
205	BAKERY PRODUCTS	EMPLOYEES	256.	20.7	20.7	20.7
206	SUGAR & CONFECTNRY	EMPLOYEES	33.	2.6	2.6	2.6
207	FATS & OILS	EMPLOYEES	49.	4.0	4.0	4.0
208	BEVERAGES	EMPLOYEES	269.	90.9	90.9	90.9
209	MISC. FOODS, ETC.	EMPLOYEES	247.	20.0	20.0	20.0
225	KNITTING MILLS	EMPLOYEES	26.	4.2	4.2	4.2
228	YARN & THREAD MLLS	EMPLOYEES	5.	.2	.2	.2
229	MISC. TEXTILE MLLS	EMPLOYEES	128.	5.3	5.3	5.3
230	APPAREL, ETC.	EMPLOYEES	22344.	1418.9	1418.9	1418.9
243	MILLWORK, PLYWOOD	EMPLOYEES	687.	34.5	34.5	34.5
244	WOOD CONTAINERS	EMPLOYEES	12.	.9	.9	.9
245	WOOD BUILDINGS ETC	EMPLOYEES	24.	1.8	1.8	1.8
249	MISC. WOOD PRODCTS	EMPLOYEES	36.	2.6	2.6	2.6
251	HOUSEHOLD FRNITURE	EMPLOYEES	97.	5.8	5.8	5.8
254	PARTITIONS, FIXTRS	EMPLOYEES	27.	1.6	1.6	1.6
259	MISC. FURNITURE	EMPLOYEES	11.	.7	.7	.7
264	MISC. CONV. PAPER	EMPLOYEES	1009.	32.7	32.7	32.7
265	PAPERBOARD CONTNRS	EMPLOYEES	400.	22.6	22.6	22.6
270	PRINTING, PUBLSHNG	EMPLOYEES	2017.	76.4	76.4	76.4
281	IND. ORGANIC CHEM.	EMPLOYEES	4.	.3	.3	.3
282	PLASTICS, SYNTHTCS	EMPLOYEES	23.	1.8	1.8	1.8
283	DRUGS	EMPLOYEES	30.	2.4	2.4	2.4
285	PAINTS & ALLIED PR	EMPLOYEES	212.	5.0	5.0	5.0
287	AGRICULTURAL CHEM.	EMPLOYEES	34.	2.2	2.2	2.2
289	MISC. CHEM. PRDCTS	EMPLOYEES	8.	.6	.6	.6
291	PETROLEUM REFINING	EMPLOYEES	263.	16.1	16.1	16.1
306	FABRIC.RUBBER, NEC	EMPLOYEES	255.	74.1	74.1	74.1
307	MISC. PLASTICS PRD	EMPLOYEES	359.	25.9	25.9	25.9
313	BOOT, SHOE STOCK	EMPLOYEES	160.	3.7	3.7	3.7
314	FOOTWEAR, EX. RUBR	EMPLOYEES	3176.	74.0	74.0	74.0
315	LEATHER GLOVES	EMPLOYEES	68.	1.6	1.6	1.6
319	LEATHER GOODS, NEC	EMPLOYEES	10.	.2	.2	.2
323	PURCHASD GLASS PRD	EMPLOYEES	6.	.2	.2	.2
324	HYDRAULIC CEMENT	EMPLOYEES	176.	6.7	6.7	6.7
325	STRUCTURL CLAY PRD	EMPLOYEES	11.	.4	.4	.4
327	CONCRETE, GYPSUM	EMPLOYEES	690.	26.4	26.4	26.4

329	MISC.NONMET.MINERL	EMPLOYEES	113.	5.7	5.7	5.7
331	BLAST FURNC & STEL	EMPLOYEES	683.	33.3	33.3	33.3
332	IRON, STEEL FOUNDR	EMPLOYEES	74.	3.6	3.6	3.6
333	PRIMARY NONFERROUS	EMPLOYEES	1909.	828.7	828.7	828.7
335	NONFERROUS ROLLING	EMPLOYEES	197.	9.6	9.6	9.6
336	NONFERROUS FOUNDRY	EMPLOYEES	183.	29.0	29.0	29.0
344	STRUCTRL STEEL PRD	EMPLOYEES	1298.	38.8	38.8	38.8
345	SCREW MACHNE PRODS	EMPLOYEES	15.	.8	.8	.8
346	METAL FORGINGS,ETC	EMPLOYEES	14.	.5	.5	.5
347	METAL SERVICES,NEC	EMPLOYEES	122.	65.1	65.1	65.1
348	ORDNANCE & ACCESS.	EMPLOYEES	63.	2.9	2.9	2.9
349	MISC. FAB. METAL	EMPLOYEES	18.	.6	.6	.6
351	ENGINES & TURBINES	EMPLOYEES	73.	2.9	2.9	2.9
354	METALWORKING MACH.	EMPLOYEES	236.	76.7	76.7	76.7
356	GENERAL IND. MACH.	EMPLOYEES	687.	27.5	27.5	27.5
358	REFRIGRATN & SERV.	EMPLOYEES	334.	15.1	15.1	15.1
359	MISC.MACH,EXC.ELEC	EMPLOYEES	342.	11.9	11.9	11.9
361	ELEC. DIST. EQUIP.	EMPLOYEES	315.	9.9	9.9	9.9
362	ELEC. IND. APPARTS	EMPLOYEES	210.	8.4	8.4	8.4
363	HOUSEHOLD APPLIANC	EMPLOYEES	156.	5.3	5.3	5.3
364	ELEC.LIGHTNG, WRNG	EMPLOYEES	148.	3.9	3.9	3.9
365	RADIO, TV RECEIVNG	EMPLOYEES	368.	9.8	9.8	9.8
366	COMMUNICATION EQPT	EMPLOYEES	1914.	42.3	42.3	42.3
367	ELECTR. COMPONENTS	EMPLOYEES	2502.	173.9	173.9	173.9
369	MISC.ELEC.EQUIPMNT	EMPLOYEES	553.	19.3	19.3	19.3
371	MOTOR VEHICLES,ETC	EMPLOYEES	851.	43.6	43.6	43.6
372	AIRCRAFT & PARTS	EMPLOYEES	19.	.5	.5	.5
381	ENG.,SCIENCE INSTR	EMPLOYEES	3.	.1	.1	.1
382	MEASURNG,CNTRL DEV	EMPLOYEES	501.	10.3	10.3	10.3
384	MEDICAL INSTRUMNTS	EMPLOYEES	47.	1.3	1.3	1.3
385	OPTHALMIC GOODS	EMPLOYEES	332.	12.7	12.7	12.7
391	JEWLERY,SILVERWARE	EMPLOYEES	21.	.3	.3	.3
394	TOYS, SPORTING GDS	EMPLOYEES	738.	80.6	80.6	80.6
396	COSTUME JEWELRY	EMPLOYEES	52.	.7	.7	.7
399	MISC. MANUFACTURES	EMPLOYEES	46.	.6	.6	.6
	TOTAL SECTOR EMPLOYMENT		50147.			
	AVERAGE DAY			3894.8	3894.8	3894.8
	MAXIMUM DAY				3894.8	3894.8

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 1990

INDUSTRIAL SECTOR

SIC CODE	CATEGORY	TYPE OF UNIT	UNITS (#)	RESTRICTED USE (1000 G/D)		
				WINTER	SUMMER	ANNUAL
201	MEAT PRODUCTS	EMPLOYEES	248.	20.1	20.1	20.1
202	DAIRY PRODUCTS	EMPLOYEES	278.	103.3	103.3	103.3
203	PRSRVD FRUITS, VEG	EMPLOYEES	860.	169.9	169.9	169.9
204	GRAIN MILL PRDCTS	EMPLOYEES	462.	37.4	37.4	37.4
205	BAKERY PRODUCTS	EMPLOYEES	256.	20.7	20.7	20.7
206	SUGAR & CONFECTNRY	EMPLOYEES	33.	2.6	2.6	2.6
207	FATS & OILS	EMPLOYEES	49.	4.0	4.0	4.0
208	BEVERAGES	EMPLOYEES	269.	90.9	90.9	90.9
209	MISC. FOODS, ETC.	EMPLOYEES	247.	20.0	20.0	20.0
225	KNITTING MILLS	EMPLOYEES	26.	4.2	4.2	4.2
228	YARN & THREAD MLLS	EMPLOYEES	5.	.2	.2	.2
229	MISC. TEXTILE MLLS	EMPLOYEES	128.	5.3	5.3	5.3
230	APPAREL, ETC.	EMPLOYEES	22344.	1418.9	1418.9	1418.9
243	MILLWORK, PLYWOOD	EMPLOYEES	687.	34.5	34.5	34.5
244	WOOD CONTAINERS	EMPLOYEES	12.	.9	.9	.9
245	WOOD BUILDINGS ETC	EMPLOYEES	24.	1.8	1.8	1.8
249	MISC. WOOD PRODCTS	EMPLOYEES	36.	2.6	2.6	2.6
251	HOUSEHOLD FRNITURE	EMPLOYEES	97.	5.8	5.8	5.8
254	PARTITIONS, FIXTRS	EMPLOYEES	27.	1.6	1.6	1.6
259	MISC. FURNITURE	EMPLOYEES	11.	.7	.7	.7
264	MISC. CONV. PAPER	EMPLOYEES	1009.	32.7	32.7	32.7
265	PAPERBOARD CONTNRS	EMPLOYEES	400.	22.6	22.6	22.6
270	PRINTING, PUBLSHNG	EMPLOYEES	2017.	76.4	76.4	76.4
281	IND. ORGANIC CHEM.	EMPLOYEES	4.	.3	.3	.3
282	PLASTICS, SYNTHTCS	EMPLOYEES	23.	1.8	1.8	1.8
283	DRUGS	EMPLOYEES	30.	2.4	2.4	2.4
285	PAINTS & ALLIED PR	EMPLOYEES	212.	5.0	5.0	5.0
287	AGRICULTURAL CHEM.	EMPLOYEES	34.	2.2	2.2	2.2
289	MISC. CHEM. PRDCTS	EMPLOYEES	8.	.6	.6	.6
291	PETROLEUM REFINING	EMPLOYEES	263.	16.1	16.1	16.1
306	FABRIC.RUBBER, NEC	EMPLOYEES	255.	74.1	74.1	74.1
307	MISC. PLASTICS PRD	EMPLOYEES	359.	25.9	25.9	25.9
313	BOOT, SHOE STOCK	EMPLOYEES	160.	3.7	3.7	3.7
314	FOOTWEAR, EX. RUBR	EMPLOYEES	3176.	74.0	74.0	74.0
315	LEATHER GLOVES	EMPLOYEES	68.	1.6	1.6	1.6
319	LEATHER GOODS, NEC	EMPLOYEES	10.	.2	.2	.2
323	PURCHASD GLASS PRD	EMPLOYEES	6.	.2	.2	.2
324	HYDRAULIC CEMENT	EMPLOYEES	176.	6.7	6.7	6.7
325	STRUCTURL CLAY PRD	EMPLOYEES	11.	.4	.4	.4
327	CONCRETE, GYPSUM	EMPLOYEES	690.	26.4	26.4	26.4

329	MISC.NONMET.MINERL	EMPLOYEES	113.	5.7	5.7	5.7
331	BLAST FURNC & STEL	EMPLOYEES	683.	33.3	33.3	33.3
332	IRON, STEEL FOUNDR	EMPLOYEES	74.	3.6	3.6	3.6
333	PRIMARY NONFERROUS	EMPLOYEES	1909.	828.7	828.7	828.7
335	NONFERROUS ROLLING	EMPLOYEES	197.	9.6	9.6	9.6
336	NONFERROUS FOUNDRY	EMPLOYEES	183.	29.0	29.0	29.0
344	STRUCTRL STEEL PRD	EMPLOYEES	1298.	38.8	38.8	38.8
345	SCREW MACHNE PRODS	EMPLOYEES	15.	.8	.8	.8
346	METAL FORGINGS,ETC	EMPLOYEES	14.	.5	.5	.5
347	METAL SERVICES,NEC	EMPLOYEES	122.	65.1	65.1	65.1
348	ORDNANCE & ACCESS.	EMPLOYEES	63.	2.9	2.9	2.9
349	MISC. FAB. METAL	EMPLOYEES	18.	.6	.6	.6
351	ENGINES & TURBINES	EMPLOYEES	73.	2.9	2.9	2.9
354	METALWORKING MACH.	EMPLOYEES	236.	76.7	76.7	76.7
356	GENERAL IND. MACH.	EMPLOYEES	687.	27.5	27.5	27.5
358	REFRIGRATN & SERV.	EMPLOYEES	334.	15.1	15.1	15.1
359	MISC.MACH,EXC.ELEC	EMPLOYEES	342.	11.9	11.9	11.9
361	ELEC. DIST. EQUIP.	EMPLOYEES	315.	9.9	9.9	9.9
362	ELEC. IND. APPARTS	EMPLOYEES	210.	8.4	8.4	8.4
363	HOUSEHOLD APPLIANC	EMPLOYEES	156.	5.3	5.3	5.3
364	ELEC.LIGHTNG, WRNG	EMPLOYEES	148.	3.9	3.9	3.9
365	RADIO, TV RECEIVNG	EMPLOYEES	368.	9.8	9.8	9.8
366	COMMUNICATION EQPT	EMPLOYEES	1914.	42.3	42.3	42.3
367	ELECTR. COMPONENTS	EMPLOYEES	2502.	173.9	173.9	173.9
369	MISC.ELEC.EQUIPMNT	EMPLOYEES	553.	19.3	19.3	19.3
371	MOTOR VEHICLES,ETC	EMPLOYEES	851.	43.6	43.6	43.6
372	AIRCRAFT & PARTS	EMPLOYEES	19.	.5	.5	.5
381	ENG.,SCIENCE INSTR	EMPLOYEES	3.	.1	.1	.1
382	MEASURNG,CNTRL DEV	EMPLOYEES	501.	10.3	10.3	10.3
384	MEDICAL INSTRUMNTS	EMPLOYEES	47.	1.3	1.3	1.3
385	OPTHALMIC GOODS	EMPLOYEES	332.	12.7	12.7	12.7
391	JEWLERY,SILVERWARE	EMPLOYEES	21.	.3	.3	.3
394	TOYS, SPORTING GDS	EMPLOYEES	738.	80.6	80.6	80.6
396	COSTUME JEWELRY	EMPLOYEES	52.	.7	.7	.7
399	MISC. MANUFACTURES	EMPLOYEES	46.	.6	.6	.6
	TOTAL SECTOR EMPLOYMENT		50147.			
	AVERAGE DAY			3894.8	3894.8	3894.8
	MAXIMUM DAY				3894.8	3894.8
- PERCENTAGE REDUCTIONS -						
	AVERAGE DAY			.0	.0	.0
	MAXIMUM DAY				.0	.0

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 1990

PUBLIC/UNACCOUNTED SECTOR

CATEGORY	UNITS (#)	UNRESTRICTED USE (1000 G/D)		
		WINTER	SUMMER	ANNUAL
LOSS (PERCENT)	0.	11754.9	11754.9	11754.9
AVERAGE DAY		11754.9	11754.9	11754.9
MAXIMUM DAY			21095.8	21095.8

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 1990

PUBLIC/UNACCOUNTED SECTOR

CATEGORY	UNITS (#)	RESTRICTED USE (1000 G/D)		
		WINTER	SUMMER	ANNUAL
LOSS (PERCENT)	0.	9614.4	9614.4	9614.4
AVERAGE DAY		9614.4	9614.4	9614.4
MAXIMUM DAY			17254.5	17254.5
- PERCENTAGE REDUCTIONS -				
AVERAGE DAY		18.2	18.2	18.2
MAXIMUM DAY			18.2	18.2

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 1990

MUNICIPAL SUMMARY

	UNRESTRICTED USE (1000 G/D)		RESTRICTED USE (1000 G/D)	
	ANNUAL AVERAGE	MAXIMUM DAY*	ANNUAL AVERAGE	MAXIMUM DAY*
RESIDENTIAL	65212.	140789.	62238.	133122.
COMMERCIAL/INSTL	26001.	26001.	26001.	26001.
INDUSTRIAL	3895.	3895.	3895.	3895.
PUBLIC/UNACCOUNTED	11755.	21096.	9614.	17254.
TOTAL MUNICIPAL	106863.	182439.	101748.	172632.

* NOTE: THE MAXIMUM DAY MUNICIPAL TOTAL IS THE SUM OF THE ANNUAL AVERAGE MUNICIPAL TOTAL AND THE LARGEST SECTORAL DIFFERENCE BETWEEN ANNUAL AND MAXIMUM DAY USE.

	PERCENTAGE REDUCTIONS	
	ANNUAL AVERAGE	MAXIMUM DAY
RESIDENTIAL	4.6	5.4
COMMERCIAL/INSTL	.0	.0
INDUSTRIAL	.0	.0
PUBLIC/UNACCOUNTED	18.2	18.2
TOTAL MUNICIPAL	4.8	5.4

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 2000

RESIDENTIAL SECTOR

FLAT RATE-SEWERED AREAS

VALUE RANGE ($1000) (1980 VALUE)	UNITS (#)	UNRESTRICTED USE (GAL/DAY/UNIT)			RESTRICTED USE (GAL/DAY/UNIT)		
		WINTER	SUMMER	ANNUAL	WINTER	SUMMER	ANNUAL
.0 - 10.0	1123.	112.	258.	185.	103.	244.	174.
10.0 - 15.0	1549.	147.	447.	297.	136.	423.	280.
15.0 - 20.0	1669.	155.	545.	350.	143.	517.	330.
20.0 - 25.5	871.	156.	636.	396.	145.	605.	375.
25.5 - 30.0	4696.	153.	714.	433.	142.	679.	410.
30.0 - 35.0	1690.	153.	787.	470.	141.	749.	445.
35.0 - 40.0	770.	165.	874.	520.	153.	833.	493.
40.0 - 51.0	1544.	214.	1039.	626.	198.	989.	593.
51.0 - 100.0	17.	282.	1509.	896.	261.	1438.	849.
TOTAL UNITS	13930.						
AVERAGE DAY PER UNIT		157.	677.	417.	145.	644.	395.
MAXIMUM DAY PER UNIT			1498.	1498.		1376.	1376.

- PERCENTAGE REDUCTIONS -

AVERAGE DAY					7.5	4.9	5.4
MAXIMUM DAY						8.2	8.2

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 2000

RESIDENTIAL SECTOR

MASTER-METERED APARTMENTS

VALUE RANGE ($1000) (1980 VALUE)	UNITS (#)	UNRESTRICTED USE (GAL/DAY/UNIT)			RESTRICTED USE (GAL/DAY/UNIT)		
		WINTER	SUMMER	ANNUAL	WINTER	SUMMER	ANNUAL
.0 - 10.0	5507.	112.	160.	136.	103.	150.	127.
10.0 - 15.0	3933.	147.	210.	178.	136.	197.	166.
15.0 - 20.0	5038.	155.	222.	188.	143.	207.	175.
20.0 - 25.5	4320.	156.	224.	190.	145.	210.	177.
25.5 - 30.0	21560.	153.	220.	186.	142.	206.	174.
30.0 - 35.0	4400.	153.	219.	186.	141.	205.	173.
35.0 - 40.0	4284.	165.	236.	201.	153.	221.	187.
40.0 - 51.0	1009.	214.	306.	260.	198.	287.	242.
51.0 - 100.0	1525.	253.	363.	308.	234.	340.	287.
TOTAL UNITS	51576.						
AVERAGE DAY PER UNIT		154.	220.	187.	142.	206.	174.
MAXIMUM DAY PER UNIT			220.	220.		203.	203.

- PERCENTAGE REDUCTIONS -

AVERAGE DAY					7.5	6.4	6.9
MAXIMUM DAY						7.7	7.7

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 2000

RESIDENTIAL SECTOR

METERED-SEWERED AREAS

VALUE RANGE ($1000) (1980 VALUE)	UNITS (#)	UNRESTRICTED USE (GAL/DAY/UNIT)			RESTRICTED USE (GAL/DAY/UNIT)		
		WINTER	SUMMER	ANNUAL	WINTER	SUMMER	ANNUAL
.0 - 10.0	7130.	200.	412.	306.	189.	392.	290.
10.0 - 15.0	8791.	209.	524.	366.	198.	498.	348.
15.0 - 20.0	13125.	216.	579.	397.	204.	551.	377.
20.0 - 25.5	16791.	222.	580.	401.	210.	552.	381.
25.5 - 30.0	14807.	228.	619.	424.	216.	588.	402.
30.0 - 35.0	15830.	236.	653.	444.	223.	621.	422.
35.0 - 40.0	12506.	243.	687.	465.	229.	653.	441.
40.0 - 50.1	19589.	254.	734.	494.	240.	698.	469.
51.0 - 60.0	9134.	269.	737.	503.	254.	701.	478.
60.0 - 80.0	9328.	287.	804.	546.	272.	764.	518.
80.0 - 100.0	3933.	318.	893.	605.	300.	849.	575.
TOTAL UNITS	130963.						
AVERAGE DAY PER UNIT		239.	650.	444.	226.	618.	422.
MAXIMUM DAY PER UNIT			963.	963.		901.	901.

- PERCENTAGE REDUCTIONS -

AVERAGE DAY					5.5	4.9	5.1
MAXIMUM DAY						6.4	6.4

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 2000

RESIDENTIAL SECTOR

SUMMARY

CATEGORY	UNITS (#)	UNRESTRICTED USE (1000 G/D)			RESTRICTED USE (1000 G/D)		
		WINTER	SUMMER	ANNUAL	WINTER	SUMMER	ANNUAL
- AVERAGE DAY -							
FLAT RATE/SWR	13930.	2187.	9429.	5808.	2023.	8969.	5496.
APARTMENTS	51576.	7932.	11367.	9650.	7337.	10638.	8988.
METERED/SEWRD	130963.	31330.	85096.	58213.	29607.	80915.	55261.
TOTALS	196469.	41449.	105892.	73671.	38967.	100522.	69745.
- MAXIMUM DAY -							
RESIDENTIAL SECTOR			158371.	158371.		147672.	147672.
- PERCENTAGE REDUCTIONS -							
AVERAGE DAY					6.0	5.1	5.3
MAXIMUM DAY						6.8	6.8

SUMMER EVAPOTRANSPIRATION (INCHES) - 18.24

SUMMER PRECIPITATION (INCHES) - 3.74

MAX. DAY EVAPOTRANSPIRATION (INCHES) - .29

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 2000

COMMERCIAL/INSTITUTIONAL SECTOR

CATEGORY	TYPE OF UNIT	UNITS (#)	UNRESTRICTED USE (1000 G/D)		
			WINTER	SUMMER	ANNUAL
MISC. COMMERCIAL	EMPLOYEES	44669.	4310.6	4310.6	4310.6
VOC. SCHOOLS	EMPLOYEES	1466.	112.1	112.1	112.1
MISC. RETAIL	EMPLOYEES	20340.	541.6	541.6	541.6
BOARDING HOUSES	EMPLOYEES	65.	6.6	6.6	6.6
TRANSP. TERMINAL	EMPLOYEES	199.	37.3	37.3	37.3
BARBER, CLEANING	EMPLOYEES	1380.	1410.7	1410.7	1410.7
LANDSCAPING	EMPLOYEES	476.	50.8	50.8	50.8
MISC. WHOLESALE	EMPLOYEES	23112.	926.8	926.8	926.8
RECREATION FACL.	EMPLOYEES	397.	330.3	330.3	330.3
FOOD AUTO RETAIL	EMPLOYEES	14875.	1950.2	1950.2	1950.2
DANCE STUDIOS	EMPLOYEES	24.	1.7	1.7	1.7
HOTELS, RESTRNTS	EMPLOYEES	12388.	6123.2	6123.2	6123.2
ELEC, GAS UTIL.	EMPLOYEES	4621.	502.8	502.8	502.8
PUBLIC ADMINIST.	EMPLOYEES	65801.	8238.3	8238.3	8238.3
SCHOOLS, UNIV.	EMPLOYEES	14181.	4264.2	4264.2	4264.2
LABS, WTR UTIL.	EMPLOYEES	3069.	1359.1	1359.1	1359.1
HEALTH SERVICES	EMPLOYEES	829.	103.8	103.8	103.8
MED. OFF. BAKERS	EMPLOYEES	2261.	245.3	245.3	245.3
NURSING FACIL.	EMPLOYEES	664.	204.4	204.4	204.4
HOSPITALS	EMPLOYEES	5237.	1070.3	1070.3	1070.3
TOTAL SECTOR EMPLOYMENT		216054.			
AVERAGE DAY			31790.1	31790.1	31790.1
MAXIMUM DAY				31790.1	31790.1

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 2000

COMMERCIAL/INSTITUTIONAL SECTOR

CATEGORY	TYPE OF UNIT	UNITS (#)	RESTRICTED USE (1000 G/D)		
			WINTER	SUMMER	ANNUAL
MISC. COMMERCIAL	EMPLOYEES	44669.	4310.6	4310.6	4310.6
VOC. SCHOOLS	EMPLOYEES	1466.	112.1	112.1	112.1
MISC. RETAIL	EMPLOYEES	20340.	541.6	541.6	541.6
BOARDING HOUSES	EMPLOYEES	65.	6.6	6.6	6.6
TRANSP. TERMINAL	EMPLOYEES	199.	37.3	37.3	37.3
BARBER, CLEANING	EMPLOYEES	1380.	1410.7	1410.7	1410.7
LANDSCAPING	EMPLOYEES	476.	50.8	50.8	50.8
MISC. WHOLESALE	EMPLOYEES	23112.	926.8	926.8	926.8
RECREATION FACL.	EMPLOYEES	397.	330.3	330.3	330.3
FOOD AUTO RETAIL	EMPLOYEES	14875.	1950.2	1950.2	1950.2
DANCE STUDIOS	EMPLOYEES	24.	1.7	1.7	1.7
HOTELS, RESTRNTS	EMPLOYEES	12388.	6123.2	6123.2	6123.2
ELEC, GAS UTIL.	EMPLOYEES	4621.	502.8	502.8	502.8
PUBLIC ADMINIST.	EMPLOYEES	65801.	8238.3	8238.3	8238.3
SCHOOLS, UNIV.	EMPLOYEES	14181.	4264.2	4264.2	4264.2
LABS, WTR UTIL.	EMPLOYEES	3069.	1359.1	1359.1	1359.1
HEALTH SERVICES	EMPLOYEES	829.	103.8	103.8	103.8
MED. OFF. BAKERS	EMPLOYEES	2261.	245.3	245.3	245.3
NURSING FACIL.	EMPLOYEES	664.	204.4	204.4	204.4
HOSPITALS	EMPLOYEES	5237.	1070.3	1070.3	1070.3
TOTAL SECTOR EMPLOYMENT		216054.			
AVERAGE DAY			31790.1	31790.1	31790.1
MAXIMUM DAY				31790.1	31790.1
- PERCENTAGE REDUCTIONS -					
AVERAGE DAY			.0	.0	.0
MAXIMUM DAY				.0	.0

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 2000

INDUSTRIAL SECTOR

SIC CODE	CATEGORY	TYPE OF UNIT	UNITS (#)	UNRESTRICTED USE (1000 G/D)		
				WINTER	SUMMER	ANNUAL
201	MEAT PRODUCTS	EMPLOYEES	214.	17.3	17.3	17.3
202	DAIRY PRODUCTS	EMPLOYEES	239.	89.0	89.0	89.0
203	PRSRVD FRUITS, VEG	EMPLOYEES	1116.	220.4	220.4	220.4
204	GRAIN MILL PRDCTS	EMPLOYEES	600.	48.6	48.6	48.6
205	BAKERY PRODUCTS	EMPLOYEES	220.	17.9	17.9	17.9
206	SUGAR & CONFECTNRY	EMPLOYEES	28.	2.3	2.3	2.3
207	FATS & OILS	EMPLOYEES	42.	3.4	3.4	3.4
208	BEVERAGES	EMPLOYEES	232.	78.4	78.4	78.4
209	MISC. FOODS, ETC.	EMPLOYEES	213.	17.2	17.2	17.2
225	KNITTING MILLS	EMPLOYEES	40.	6.4	6.4	6.4
228	YARN & THREAD MLLS	EMPLOYEES	7.	.4	.4	.4
229	MISC. TEXTILE MLLS	EMPLOYEES	195.	8.0	8.0	8.0
230	APPAREL, ETC.	EMPLOYEES	28686.	1821.6	1821.6	1821.6
243	MILLWORK, PLYWOOD	EMPLOYEES	590.	29.7	29.7	29.7
244	WOOD CONTAINERS	EMPLOYEES	10.	.8	.8	.8
245	WOOD BUILDINGS ETC	EMPLOYEES	21.	1.5	1.5	1.5
249	MISC. WOOD PRODCTS	EMPLOYEES	31.	2.2	2.2	2.2
251	HOUSEHOLD FRNITURE	EMPLOYEES	111.	6.6	6.6	6.6
254	PARTITIONS, FIXTRS	EMPLOYEES	31.	1.8	1.8	1.8
259	MISC. FURNITURE	EMPLOYEES	13.	.8	.8	.8
264	MISC. CONV. PAPER	EMPLOYEES	1230.	39.9	39.9	39.9
265	PAPERBOARD CONTNRS	EMPLOYEES	455.	25.7	25.7	25.7
270	PRINTING, PUBLSHNG	EMPLOYEES	2249.	85.3	85.3	85.3
281	IND. ORGANIC CHEM.	EMPLOYEES	7.	.4	.4	.4
282	PLASTICS, SYNTHTCS	EMPLOYEES	36.	2.8	2.8	2.8
283	DRUGS	EMPLOYEES	46.	3.7	3.7	3.7
285	PAINTS & ALLIED PR	EMPLOYEES	328.	7.7	7.7	7.7
287	AGRICULTURAL CHEM.	EMPLOYEES	52.	3.4	3.4	3.4
289	MISC. CHEM. PRDCTS	EMPLOYEES	13.	.9	.9	.9
291	PETROLEUM REFINING	EMPLOYEES	360.	22.0	22.0	22.0
306	FABRIC.RUBBER, NEC	EMPLOYEES	263.	76.7	76.7	76.7
307	MISC. PLASTICS PRD	EMPLOYEES	371.	26.8	26.8	26.8
313	BOOT, SHOE STOCK	EMPLOYEES	197.	4.6	4.6	4.6
314	FOOTWEAR, EX. RUBR	EMPLOYEES	3896.	90.8	90.8	90.8
315	LEATHER GLOVES	EMPLOYEES	83.	1.9	1.9	1.9
319	LEATHER GOODS, NEC	EMPLOYEES	12.	.3	.3	.3
323	PURCHASD GLASS PRD	EMPLOYEES	6.	.2	.2	.2
324	HYDRAULIC CEMENT	EMPLOYEES	176.	6.8	6.8	6.8
325	STRUCTURL CLAY PRD	EMPLOYEES	11.	.4	.4	.4
327	CONCRETE, GYPSUM	EMPLOYEES	692.	26.5	26.5	26.5

329	MISC.NONMET.MINERL	EMPLOYEES	113.	5.7	5.7	5.7
331	BLAST FURNC & STEL	EMPLOYEES	718.	35.0	35.0	35.0
332	IRON, STEEL FOUNDR	EMPLOYEES	56.	2.7	2.7	2.7
333	PRIMARY NONFERROUS	EMPLOYEES	2006.	870.8	870.8	870.8
335	NONFERROUS ROLLING	EMPLOYEES	148.	7.2	7.2	7.2
336	NONFERROUS FOUNDRY	EMPLOYEES	138.	21.8	21.8	21.8
344	STRUCTRL STEEL PRD	EMPLOYEES	1679.	50.2	50.2	50.2
345	SCREW MACHNE PRODS	EMPLOYEES	20.	1.0	1.0	1.0
346	METAL FORGINGS,ETC	EMPLOYEES	18.	.6	.6	.6
347	METAL SERVICES,NEC	EMPLOYEES	157.	84.2	84.2	84.2
348	ORDNANCE & ACCESS.	EMPLOYEES	82.	3.8	3.8	3.8
349	MISC. FAB. METAL	EMPLOYEES	24.	.8	.8	.8
351	ENGINES & TURBINES	EMPLOYEES	93.	3.7	3.7	3.7
354	METALWORKING MACH.	EMPLOYEES	299.	97.3	97.3	97.3
356	GENERAL IND. MACH.	EMPLOYEES	872.	35.0	35.0	35.0
358	REFRIGRATN & SERV.	EMPLOYEES	424.	19.1	19.1	19.1
359	MISC.MACH,EXC.ELEC	EMPLOYEES	434.	15.1	15.1	15.1
361	ELEC. DIST. EQUIP.	EMPLOYEES	417.	13.1	13.1	13.1
362	ELEC. IND. APPARTS	EMPLOYEES	278.	11.1	11.1	11.1
363	HOUSEHOLD APPLIANC	EMPLOYEES	206.	7.0	7.0	7.0
364	ELEC.LIGHTNG, WRNG	EMPLOYEES	196.	5.2	5.2	5.2
365	RADIO, TV RECEIVNG	EMPLOYEES	487.	12.9	12.9	12.9
366	COMMUNICATION EQPT	EMPLOYEES	2533.	56.0	56.0	56.0
367	ELECTR. COMPONENTS	EMPLOYEES	3311.	230.1	230.1	230.1
369	MISC.ELEC.EQUIPMNT	EMPLOYEES	732.	25.5	25.5	25.5
371	MOTOR VEHICLES,ETC	EMPLOYEES	1200.	61.4	61.4	61.4
372	AIRCRAFT & PARTS	EMPLOYEES	27.	.7	.7	.7
381	ENG.,SCIENCE INSTR	EMPLOYEES	7.	.3	.3	.3
382	MEASURNG,CNTRL DEV	EMPLOYEES	616.	12.7	12.7	12.7
384	MEDICAL INSTRUMNTS	EMPLOYEES	107.	3.0	3.0	3.0
385	OPTHALMIC GOODS	EMPLOYEES	752.	28.8	28.8	28.8
391	JEWLERY,SILVERWARE	EMPLOYEES	13.	.2	.2	.2
394	TOYS, SPORTING GDS	EMPLOYEES	455.	49.7	49.7	49.7
396	COSTUME JEWELRY	EMPLOYEES	32.	.4	.4	.4
399	MISC. MANUFACTURES	EMPLOYEES	28.	.4	.4	.4
	TOTAL SECTOR EMPLOYMENT		61801.			
	AVERAGE DAY			4573.3	4573.3	4573.3
	MAXIMUM DAY				4573.3	4573.3

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 2000

INDUSTRIAL SECTOR

SIC CODE	CATEGORY	TYPE OF UNIT	UNITS (#)	RESTRICTED USE (1000 G/D)		
				WINTER	SUMMER	ANNUAL
201	MEAT PRODUCTS	EMPLOYEES	214.	17.3	17.3	17.3
202	DAIRY PRODUCTS	EMPLOYEES	239.	89.0	89.0	89.0
203	PRSRVD FRUITS, VEG	EMPLOYEES	1116.	220.4	220.4	220.4
204	GRAIN MILL PRDCTS	EMPLOYEES	600.	48.6	48.6	48.6
205	BAKERY PRODUCTS	EMPLOYEES	220.	17.9	17.9	17.9
206	SUGAR & CONFECTNRY	EMPLOYEES	28.	2.3	2.3	2.3
207	FATS & OILS	EMPLOYEES	42.	3.4	3.4	3.4
208	BEVERAGES	EMPLOYEES	232.	78.4	78.4	78.4
209	MISC. FOODS, ETC.	EMPLOYEES	213.	17.2	17.2	17.2
225	KNITTING MILLS	EMPLOYEES	40.	6.4	6.4	6.4
228	YARN & THREAD MLLS	EMPLOYEES	7.	.4	.4	.4
229	MISC. TEXTILE MLLS	EMPLOYEES	195.	8.0	8.0	8.0
230	APPAREL, ETC.	EMPLOYEES	28686.	1821.6	1821.6	1821.6
243	MILLWORK, PLYWOOD	EMPLOYEES	590.	29.7	29.7	29.7
244	WOOD CONTAINERS	EMPLOYEES	10.	.8	.8	.8
245	WOOD BUILDINGS ETC	EMPLOYEES	21.	1.5	1.5	1.5
249	MISC. WOOD PRODCTS	EMPLOYEES	31.	2.2	2.2	2.2
251	HOUSEHOLD FRNITURE	EMPLOYEES	111.	6.6	6.6	6.6
254	PARTITIONS, FIXTRS	EMPLOYEES	31.	1.8	1.8	1.8
259	MISC. FURNITURE	EMPLOYEES	13.	.8	.8	.8
264	MISC. CONV. PAPER	EMPLOYEES	1230.	39.9	39.9	39.9
265	PAPERBOARD CONTNRS	EMPLOYEES	455.	25.7	25.7	25.7
270	PRINTING, PUBLSHNG	EMPLOYEES	2249.	85.3	85.3	85.3
281	IND. ORGANIC CHEM.	EMPLOYEES	7.	.4	.4	.4
282	PLASTICS, SYNTHTCS	EMPLOYEES	36.	2.8	2.8	2.8
283	DRUGS	EMPLOYEES	46.	3.7	3.7	3.7
285	PAINTS & ALLIED PR	EMPLOYEES	328.	7.7	7.7	7.7
287	AGRICULTURAL CHEM.	EMPLOYEES	52.	3.4	3.4	3.4
289	MISC. CHEM. PRDCTS	EMPLOYEES	13.	.9	.9	.9
291	PETROLEUM REFINING	EMPLOYEES	360.	22.0	22.0	22.0
306	FABRIC.RUBBER, NEC	EMPLOYEES	263.	76.7	76.7	76.7
307	MISC. PLASTICS PRD	EMPLOYEES	371.	26.8	26.8	26.8
313	BOOT, SHOE STOCK	EMPLOYEES	197.	4.6	4.6	4.6
314	FOOTWEAR, EX. RUBR	EMPLOYEES	3896.	90.8	90.8	90.8
315	LEATHER GLOVES	EMPLOYEES	83.	1.9	1.9	1.9
319	LEATHER GOODS, NEC	EMPLOYEES	12.	.3	.3	.3
323	PURCHASD GLASS PRD	EMPLOYEES	6.	.2	.2	.2
324	HYDRAULIC CEMENT	EMPLOYEES	176.	6.8	6.8	6.8
325	STRUCTURL CLAY PRD	EMPLOYEES	11.	.4	.4	.4
327	CONCRETE, GYPSUM	EMPLOYEES	692.	26.5	26.5	26.5

329	MISC.NONMET.MINERL	EMPLOYEES	113.	5.7	5.7	5.7
331	BLAST FURNC & STEL	EMPLOYEES	718.	35.0	35.0	35.0
332	IRON, STEEL FOUNDR	EMPLOYEES	56.	2.7	2.7	2.7
333	PRIMARY NONFERROUS	EMPLOYEES	2006.	870.8	870.8	870.8
335	NONFERROUS ROLLING	EMPLOYEES	148.	7.2	7.2	7.2
336	NONFERROUS FOUNDRY	EMPLOYEES	138.	21.8	21.8	21.8
344	STRUCTRL STEEL PRD	EMPLOYEES	1679.	50.2	50.2	50.2
345	SCREW MACHNE PRODS	EMPLOYEES	20.	1.0	1.0	1.0
346	METAL FORGINGS,ETC	EMPLOYEES	18.	.6	.6	.6
347	METAL SERVICES,NEC	EMPLOYEES	157.	84.2	84.2	84.2
348	ORDNANCE & ACCESS.	EMPLOYEES	82.	3.8	3.8	3.8
349	MISC. FAB. METAL	EMPLOYEES	24.	.8	.8	.8
351	ENGINES & TURBINES	EMPLOYEES	93.	3.7	3.7	3.7
354	METALWORKING MACH.	EMPLOYEES	299.	97.3	97.3	97.3
356	GENERAL IND. MACH.	EMPLOYEES	872.	35.0	35.0	35.0
358	REFRIGRATN & SERV.	EMPLOYEES	424.	19.1	19.1	19.1
359	MISC.MACH,EXC.ELEC	EMPLOYEES	434.	15.1	15.1	15.1
361	ELEC. DIST. EQUIP.	EMPLOYEES	417.	13.1	13.1	13.1
362	ELEC. IND. APPARTS	EMPLOYEES	278.	11.1	11.1	11.1
363	HOUSEHOLD APPLIANC	EMPLOYEES	206.	7.0	7.0	7.0
364	ELEC.LIGHTNG, WRNG	EMPLOYEES	196.	5.2	5.2	5.2
365	RADIO, TV RECEIVNG	EMPLOYEES	487.	12.9	12.9	12.9
366	COMMUNICATION EQPT	EMPLOYEES	2533.	56.0	56.0	56.0
367	ELECTR. COMPONENTS	EMPLOYEES	3311.	230.1	230.1	230.1
369	MISC.ELEC.EQUIPMNT	EMPLOYEES	732.	25.5	25.5	25.5
371	MOTOR VEHICLES,ETC	EMPLOYEES	1200.	61.4	61.4	61.4
372	AIRCRAFT & PARTS	EMPLOYEES	27.	.7	.7	.7
381	ENG.,SCIENCE INSTR	EMPLOYEES	7.	.3	.3	.3
382	MEASURNG,CNTRL DEV	EMPLOYEES	616.	12.7	12.7	12.7
384	MEDICAL INSTRUMNTS	EMPLOYEES	107.	3.0	3.0	3.0
385	OPTHALMIC GOODS	EMPLOYEES	752.	28.8	28.8	28.8
391	JEWLERY,SILVERWARE	EMPLOYEES	13.	.2	.2	.2
394	TOYS, SPORTING GDS	EMPLOYEES	455.	49.7	49.7	49.7
396	COSTUME JEWELRY	EMPLOYEES	32.	.4	.4	.4
399	MISC. MANUFACTURES	EMPLOYEES	28.	.4	.4	.4
	TOTAL SECTOR EMPLOYMENT		61801.			
	AVERAGE DAY			4573.3	4573.3	4573.3
	MAXIMUM DAY				4573.3	4573.3
- PERCENTAGE REDUCTIONS -						
	AVERAGE DAY			.0	.0	.0
	MAXIMUM DAY				.0	.0

REPORT NO. 2000-10

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 2000

PUBLIC/UNACCOUNTED SECTOR

CATEGORY	UNITS (#)	UNRESTRICTED USE (1000 G/D)		
		WINTER	SUMMER	ANNUAL
LOSS (PERCENT)	0.	13599.7	13599.7	13599.7
AVERAGE DAY		13599.7	13599.7	13599.7
MAXIMUM DAY			24068.3	24068.3

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 2000

PUBLIC/UNACCOUNTED SECTOR

CATEGORY	UNITS (#)	RESTRICTED USE (1000 G/D)		
		WINTER	SUMMER	ANNUAL
LOSS (PERCENT)	0.	9887.0	9887.0	9887.0
AVERAGE DAY		9887.0	9887.0	9887.0
MAXIMUM DAY			17497.7	17497.7
- PERCENTAGE REDUCTIONS -				
AVERAGE DAY		27.3	27.3	27.3
MAXIMUM DAY			27.3	27.3

IWR MAIN SYSTEM VER. 5.1

STUDY AREA - ARIDWEST USA PREDICTED WATER USE FOR YEAR - 2000

MUNICIPAL SUMMARY

	UNRESTRICTED USE (1000 G/D)		RESTRICTED USE (1000 G/D)	
	ANNUAL AVERAGE	MAXIMUM DAY*	ANNUAL AVERAGE	MAXIMUM DAY*
RESIDENTIAL	73670.	158371.	69744.	147672.
COMMERCIAL/INSTL	31790.	31790.	31790.	31790.
INDUSTRIAL	4573.	4573.	4573.	4573.
PUBLIC/UNACCOUNTED	13600.	24068.	9887.	17498.
TOTAL MUNICIPAL	123633.	208334.	115995.	193922.

* NOTE: THE MAXIMUM DAY MUNICIPAL TOTAL IS THE SUM OF THE ANNUAL AVERAGE MUNICIPAL TOTAL AND THE LARGEST SECTORAL DIFFERENCE BETWEEN ANNUAL AND MAXIMUM DAY USE.

	PERCENTAGE REDUCTIONS	
	ANNUAL AVERAGE	MAXIMUM DAY
RESIDENTIAL	5.3	6.8
COMMERCIAL/INSTL	.0	.0
INDUSTRIAL	.0	.0
PUBLIC/UNACCOUNTED	27.3	27.3
TOTAL MUNICIPAL	6.2	6.9

IWR MAIN SYSTEM

VER. 5.1

STUDY AREA - ARIDWEST USA

(1000 GALLONS PER DAY)

		UNRESTRICTED USE		RESTRICTED USE	
RUN NO.	YEAR	ANNUAL AVERAGE	MAXIMUM DAY	ANNUAL AVERAGE	MAXIMUM DAY
1	1980	91110.	154466.	88934.	149185.
2	1990	106863.	182439.	101748.	172632.
3	2000	123633.	208334.	115995.	193922.

EXHIBIT A-4 CONSERVATION OUTPUT (.COV) FILE

COVERAGE FACTORS SPECIFIED BY USER AND COMPUTED FROM
LIBRARY OF CONSERVATION COEFFICIENTS
AND
EFFECTIVENESS OF MEASURES BY SECTOR AND DIMENSION

ONLY SELECTED MEASURES ARE INCLUDED. VALUES FOR UNSELECTED SECTORS OF SELECTED MEASURES ARE SET TO 0.000.

COVERAGE FACTORS FOR YEAR: 1980.

SECTORS: MEASURES	RESIDENTIAL METERED	RESIDENTIAL UNMETERD	RESIDENTIAL APARTMNT	COMMERCL	INDUSTRL	PUBLIC & OTHER	UNACCOUNT
EDUCATION	.950	.950	.950	.000	.000	.000	.000
LEAK REPAIR	.000	.000	.000	.000	.000	.000	.000
MODERATE CODE	.097	.097	.097	.000	.000	.000	.000
LANDSCAPE-NEW	.077	.077	.077	.000	.000	.000	.000

EFFECTIVENESS OF MEASURES FOR YEAR: 1980.
(1000 GALLONS PER DAY)

SECTORS: MEASURES	RESIDENTIAL METERED	RESIDENTIAL UNMETERD	RESIDENTIAL APARTMNT	COMMERCL	INDUSTRL	PUBLIC & OTHER	UNACCOUNT
EDUCATION							
INDOOR	794.493	50.214	178.538	.000	.000	.000	.000
OUTDOOR	1347.907	134.308	77.307	.000	.000	.000	.000
MAX-DAY	3226.341	427.400	255.846	.000	.000	.000	.000
LEAK REPAIR							
INDOOR	.000	.000	.000	.000	.000	.000	.000
OUTDOOR	.000	.000	.000	.000	.000	.000	.000
MAX-DAY	.000	.000	.000	.000	.000	.000	.000
MODERATE CODE							
INDOOR	183.104	22.266	79.169	.000	.000	.000	.000
OUTDOOR	.000	.000	.000	.000	.000	.000	.000
MAX-DAY	743.563	189.521	113.449	.000	.000	.000	.000
LANDSCAPE-NEW							
INDOOR	.000	.000	.000	.000	.000	.000	.000
OUTDOOR	162.316	9.953	4.118	.000	.000	.000	.000
MAX-DAY	388.519	31.673	13.627	.000	.000	.000	.000
TOTAL EFFECTIVENESS							
INDOOR	977.596	72.480	257.708	.000	.000	.000	.000
OUTDOOR	1510.223	144.261	81.425	.000	.000	.000	.000
MAX-DAY	4358.423	648.594	382.922	.000	.000	.000	.000
IMPACT OF INTERACTION FACTORS							
INDOOR	.000	.000	.000	.000	.000	.000	.000
OUTDOOR	.000	.000	.000	.000	.000	.000	.000
MAX-DAY	.000	.000	.000	.000	.000	.000	.000
ADJUSTED EFFECTIVENESS							
INDOOR	977.596	72.480	257.708	.000	.000	.000	.000
OUTDOOR	1510.223	144.261	81.425	.000	.000	.000	.000
MAX-DAY	4358.423	648.594	382.922	.000	.000	.000	.000

COVERAGE FACTORS FOR YEAR: 1990.

SECTORS: MEASURES	RESIDENTIAL METERED	RESIDENTIAL UNMETERD	RESIDENTIAL APARTMNT	COMMERCL	INDUSTRL	PUBLIC & OTHER	UNACCOUNT
EDUCATION	.950	.950	.950	.000	.000	.000	.000
LEAK REPAIR	.000	.000	.000	.000	.000	.000	.667
MODERATE CODE	.163	.163	.163	.000	.000	.000	.000
LANDSCAPE-NEW	.166	.166	.166	.000	.000	.000	.000

EFFECTIVENESS OF MEASURES FOR YEAR: 1990.
(1000 GALLONS PER DAY)

SECTORS: MEASURES	RESIDENTIAL METERED	RESIDENTIAL UNMETERD	RESIDENTIAL APARTMNT	COMMERCL	INDUSTRL	PUBLIC & OTHER	UNACCOUNT
EDUCATION							
INDOOR	919.740	64.835	230.806	.000	.000	.000	.000
OUTDOOR	1585.050	220.859	99.939	.000	.000	.000	.000
MAX-DAY	3721.604	628.880	330.744	.000	.000	.000	.000
LEAK REPAIR							
INDOOR	.000	.000	.000	.000	.000	.000	1712.368
OUTDOOR	.000	.000	.000	.000	.000	.000	428.092
MAX-DAY	.000	.000	.000	.000	.000	.000	3841.359
MODERATE CODE							
INDOOR	356.195	48.311	171.983	.000	.000	.000	.000
OUTDOOR	.000	.000	.000	.000	.000	.000	.000
MAX-DAY	1441.296	468.605	246.452	.000	.000	.000	.000
LANDSCAPE-NEW							
INDOOR	.000	.000	.000	.000	.000	.000	.000
OUTDOOR	411.493	35.284	11.476	.000	.000	.000	.000
MAX-DAY	966.162	100.469	37.978	.000	.000	.000	.000
TOTAL EFFECTIVENESS							
INDOOR	1275.935	113.147	402.789	.000	.000	.000	1712.368
OUTDOOR	1996.544	256.144	111.414	.000	.000	.000	428.092
MAX-DAY	6129.062	1197.954	615.175	.000	.000	.000	3841.359
IMPACT OF INTERACTION FACTORS							
INDOOR	.000	.000	.000	.000	.000	.000	.000
OUTDOOR	.000	.000	.000	.000	.000	.000	.000
MAX-DAY	.000	.000	.000	.000	.000	.000	.000
ADJUSTED EFFECTIVENESS							
INDOOR	1275.935	113.147	402.789	.000	.000	.000	1712.368
OUTDOOR	1996.544	256.144	111.414	.000	.000	.000	428.092
MAX-DAY	6129.062	1197.954	615.175	.000	.000	.000	3841.359

COVERAGE FACTORS FOR YEAR: 2000.

SECTORS: MEASURES	RESIDENTIAL METERED	UNMETERD	APARTMNT	COMMERCL	INDUSTRL	PUBLIC & OTHER	UNACCOUNT
EDUCATION	.950	.950	.950	.000	.000	.000	.000
LEAK REPAIR	.000	.000	.000	.000	.000	.000	1.000
MODERATE CODE	.275	.275	.275	.000	.000	.000	.000
LANDSCAPE-NEW	.240	.240	.240	.000	.000	.000	.000

EFFECTIVENESS OF MEASURES FOR YEAR: 2000.
(1000 GALLONS PER DAY)

SECTORS: MEASURES	RESIDENTIAL METERED	UNMETERD	APARTMNT	COMMERCL	INDUSTRL	PUBLIC & OTHER	UNACCOUNT
EDUCATION							
INDOOR	1041.709	72.715	263.747	.000	.000	.000	.000
OUTDOOR	1787.724	240.802	114.202	.000	.000	.000	.000
MAX-DAY	4193.862	694.033	377.949	.000	.000	.000	.000
LEAK REPAIR							
INDOOR	.000	.000	.000	.000	.000	.000	2970.168
OUTDOOR	.000	.000	.000	.000	.000	.000	742.542
MAX-DAY	.000	.000	.000	.000	.000	.000	6570.656
MODERATE CODE							
INDOOR	680.635	91.414	331.567	.000	.000	.000	.000
OUTDOOR	.000	.000	.000	.000	.000	.000	.000
MAX-DAY	2740.200	872.498	475.136	.000	.000	.000	.000
LANDSCAPE-NEW							
INDOOR	.000	.000	.000	.000	.000	.000	.000
OUTDOOR	671.001	55.620	18.959	.000	.000	.000	.000
MAX-DAY	1574.117	160.306	62.745	.000	.000	.000	.000
TOTAL EFFECTIVENESS							
INDOOR	1722.344	164.129	595.314	.000	.000	.000	2970.168
OUTDOOR	2458.725	296.422	133.162	.000	.000	.000	742.542
MAX-DAY	8508.180	1726.837	915.830	.000	.000	.000	6570.656
IMPACT OF INTERACTION FACTORS							
INDOOR	.000	.000	.000	.000	.000	.000	.000
OUTDOOR	.000	.000	.000	.000	.000	.000	.000
MAX-DAY	-.001	.000	.000	.000	.000	.000	.000
ADJUSTED EFFECTIVENESS							
INDOOR	1722.344	164.129	595.314	.000	.000	.000	2970.168
OUTDOOR	2458.725	296.422	133.162	.000	.000	.000	742.542
MAX-DAY	8508.181	1726.837	915.830	.000	.000	.000	6570.656

APPENDIX B

HISTORICAL DEVELOPMENT OF THE IWR-MAIN SYSTEM

HISTORICAL DEVELOPMENT OF THE IWR-MAIN SYSTEM

MAIN II

The IWR-MAIN System was based on the MAIN System developed by Hittman Associates, Inc., in the late 1960s for the U.S. Office of Water Resources Research. The MAIN (versions 1.0, 1.1, and 2.0) Forecasting System was in turn based on earlier work by Howe and Linaweaver (1967), Wolff et al. (1966), and other investigators. Most of these investigators were involved with the Residential and Commercial Water Use Research Projects carried on at the Johns Hopkins University. These two studies generated the best water use data to date. The work of the investigators of the Residential Water Use Research Project resulted in significant insights into the explanatory factors affecting residential water use. The data base consists of observations on average values for water use and socioeconomic and climatic characteristics for 39 residential areas served by 16 water utilities. Recordings of water consumption in 15-minute intervals were taken for periods ranging from two to three years during 1961-63. These were later aggregated to hourly, daily, seasonal, and annual figures. In-house (domestic) and summer-sprinkling (outdoor) uses were separated. Howe and Linaweaver (1967) used this massive data base to estimate demand models for the eastern and western parts of the country. These demand models were considered to be among the best predictive equations of residential water demand.

The MAIN System was intended to provide a computer-based program which would allow the preparation of disaggregate water use forecasts using the best models and approaches available at the time. Research from the Johns Hopkins University and Howe and Linaweaver (1967), as well as data gathered from the U.S. Census, American Water Works Association, and others, resulted in a series of sophisticated models of water use. The MAIN System was sectorally disaggregated in that it allowed for independent calculations of water estimates for metered and flat rate sewered residences, commercial establishments, manufacturing categories (by SIC codes), and public/unaccounted water requirements. Version 2.0 of the MAIN System, also known as MAIN II, provided growth models to project water use parameters used in these calculations.

IWR-MAIN

In the early 1980s, the Institute for Water Resources (IWR), U.S. Army Corps of Engineers, selected the MAIN System as a tool for improving water use forecasting practices within the Corps and renamed it the IWR-MAIN Water Use Forecasting System. Major modifications to the IWR-MAIN System (versions 2.1 to 2.3) included:

(1) Changes in the computer program to allow operation on time-shared computer systems.

(2) Changes in the residential model and other socioeconomic coefficients to accept values in 1980 constant dollars.

In 1985 the IWR-MAIN System (versions 2.4 to 3.2) underwent substantial modifications which included:

(1) Development of a PC version to allow for IBM or compatible personal computer use.

(2) Replacement of water use computational models with new models and coefficients based on data and research literature available in 1984:

a. Residential Sector: demand models were changed to reflect new estimates by Howe (1982) based on the addition of the bill difference variable.

b. Commercial/Institutional Sector: unit use parameters for this sector were changed from establishment characteristics (e.g., square footage of offices, car stalls of drive-ins, seats of restaurants) to employment parameters for commercial categories (C0xx) based on SIC groupings of nonmanufacturing establishments.

c. Industrial Sector: parameter unit use coefficients were updated based on the 1977 Census of Manufacturers: Water Use in Manufacturing survey.

d. Public/Unaccounted Sector: changes were made allowing the option of calculating distribution losses as a specified fraction of total water use.

(3) Elimination of peak-hour water use and the metered and septic tank residential category. A category for master-metered apartments was added.

(4) Various changes in displays of the PC version and the mainframe interfaces.

Version 4.0, released in 1986, contained completely respecified and reestimated internal growth models. These econometric models were based on historical Census data gathered at the SMSA (Standard Metropolitan Statistical Area) level for the years 1960, 1970, and 1980 (housing data) and 1972, 1979, and 1982 (employment data). Modifications to the PC version included changes in the data entry screens, editing, execution, and the output of reports.

Version 5.0, released in 1987, provided a new conservation subroutine allowing the option of computing restricted water use based on conservation measures. The industrial sector water use coefficients were updated to reflect the 1982 Census of Manufacturers: Water Use in Manufacturing. Slight enhancements were also made to the PC version.

Version 5.1, released in December, 1987, provides an expanded number of entries in the external projection screens, a nonresidential price adjustment factor, a residential metered summer weather adjustment factor for calibration purposes, revised commercial and industrial coefficients, the computation of conservation effectiveness by individual measure, new save file options, a more efficient print/view routine, and more detailed help files. Utilities were also added for converting data files from previous versions to the current data file format and for conversion from a .DAT file to a data file. See Table B-1 for a complete historical development of the IWR-MAIN System.

TABLE B-1

SUMMARY OF RELEASED AND UNRELEASED IWR-MAIN SYSTEM VERSIONS

Version No.	Generic Name	Release Date	Application	Author, Documentation, Notes
1.0	MAIN I	1968	Estimating M&I water use (no internal forecasting capability)	Hittman Associates, Inc., Columbia, MD Report HIT-336, "MAIN I - A System of Computerized Models for Calculating and Evaluating Municipal Water Requirements," 2 vols., June 1968 Program written in ANSI FORTRAN IV (FORTRAN 66) for batch processing on mainframe computers Water use computational models based on data and literature available in 1967 Note: Computer program and documentation contained errors
1.1	MAIN I	1968	Estimating M&I water use (no internal forecasting capability)	Hittman Associates, Inc., Columbia, MD Report HIT-336 (addendum) "Addendum to Final Report - MAIN I - A System of Computerized Models for Calculating and Evaluating Municipal Water Requirements," October 1969 Release 1.0 errors corrected
2.0	MAIN II	1969	Estimating & forecasting M&I water use (limited internal forecasting capability)	Hittman Associates, Inc., Columbia, MD Report HIT-413, "Forecasting Municipal Water Requirements - The MAIN II System," 2 vols., September 1969 Water use computational models unchanged from release 1.1; two internal and one external forecasting methods added

TABLE B-1 (Continued)

Version No.	Generic Name	Release Date	Application	Author, Documentation, Notes
2.1	IWR-MAIN	1982	Estimating & forecasting M&I water use (limited internal forecasting capability)	Institute for Water Resources, U.S. Army Corps of Engineers, Fort Belvoir, VA [no published documentation] Similar to release 2.0, modified for use on CDC computer at Boeing Computer Service Co. (batch processing)
2.2	IWR-MAIN	1983	Estimating & forecasting M&I water use (limited internal forecasting capability)	Institute for Water Resources, U.S. Army Corps of Engineers, Fort Belvoir, VA "Forecasting Municipal and Industrial Water Use: IWR-MAIN System User's Guide for Interactive Processing and User's Manual," research report 83R-3 July 1983 Residential model coefficients modified to accept prices and housing values in 1980 dollars. External procedures IWREDIT, IWRRUN, and IWRPRNT provided to facilitate data loading, execution, and report generation on Boeing system (quasiinteractive mode)
2.3	IWR-MAIN	1984	Estimating & forecasting M&I water use (limited internal forecasting capability)	Institute for Water Resources, U.S. Army Corps of Engineers, Fort Belvoir, VA [documentation not released] Similar to release 2.2, modified for use on CDC Cybernet System

TABLE B-1 (Continued)

Version No.	Generic Name	Release Date	Application	Author, Documentation, Notes
2.4	IWR-MAIN	1985	Estimating & forecasting M&I water use (limited internal forecasting capability)	Institute for Water Resources, U.S. Army Corps of Engineers, Fort Belvoir, VA [documentation not released] Similar to release 2.3, modified for use on IBM or IBM-compatible personal computer Interactive user interface provided to facilitate data entry, editing, execution, and report generation (e.g., IWREDIT, IWRRUN, and IWRPRINT)
3.0	IWR-MAIN	1985	Estimating M&I water use (internal forecasting capability deactivated)	Institute for Water Resources, U.S. Army Corps of Engineers, Fort Belvoir, VA [documentation not released] Water use computational models replaced with new models based on data and literature available in 1984; commercial/institutional and industrial categories revised Calculation of peak hour water use omitted; minor changes to displays; metered-septic tank residential category deleted, category added for master-metered apartments; optional method of calculating distribution losses added; provision made for user input of climatic data; internal parameter projection procedures operational for residential sector only

TABLE B-1 (Continued)

Version No.	Generic Name	Release Date	Application	Author, Documentation, Notes
3.1	IWR-MAIN	1985	Estimating M&I water use (internal forecasting capability deactivated)	Institute for Water Resources, U.S. Army Corps of Engineers, Fort Belvoir, VA [documentation not released] Similar to version 3.0, except machine-specific UNPACK subroutine eliminated, new nonspecific DCODE subroutine provided; increased error-checking for input and library data
3.2	IWR-MAIN	1985	Estimating M&I water use (internal forecasting capability deactivated)	Institute for Water Resources, U.S. Army Corps of Engineers, Fort Belvoir, VA [documentation not released] Similar to version 3.0, modified for use on IBM or IBM-compatible personal computer Interactive user interface provided to facilitate data entry, editing, execution, and report generation
4.0	IWR-MAIN	1986	Estimating & forecasting M&I water use (fully operative and complete internal forecasting capability)	Institute for Water Resources, U.S. Army Corps of Engineers, Fort Belvoir, VA [documentation not released] This version is for both mainframe and IBM-compatible PC applications Provided new, complete internal forecasting procedures, similar to those in versions 2.x, except based on data and research available in 1985. External procedures IWREDIT, IWRRUN, and IWRPRNT no longer supported. Interactive user interface provided for PC applications to facilitate data entry, editing, and execution. New utility provided for report review and generation

TABLE B-1 (Continued)

Version No.	Generic Name	Release Date	Application	Author, Documentation, Notes
5.0	IWR-MAIN	1987	Estimating & forecasting M&I water use and evaluation of conservation measures (fully operative and complete internal forecasting capability)	Institute for Water Resources, U.S. Army Corps of Engineers, Fort Belvoir, VA "IWR-MAIN Water Use Forecasting System: User's Manual and System Description," two parts, March 1987 Water Conservation Algorithm added. Changes in industrial sector water use coefficients reflecting 1982 data Enhancements made to the Personal Computer version including data entry, editing, execution, and output reporting
5.1	IWR-MAIN	1987	Estimating & forecasting M&I water use and evaluation of conservation measures (fully operative and complete internal forecasting capability)	Institute for Water Resources, U.S. Army Corps of Engineers, Fort Belvoir, VA "IWR-MAIN Water Use Forecasting System: User's Manual and System Description," two parts, December 1987 Expansion of external projection screens. Updated nonresidential coefficients and nonresidential price adjustment factor added. Residential summer weather adjustment factor added for calibration purposes. Computation of effectiveness of individual conservation measures added. More efficient Print/View routine provided and new utilities added.

APPENDIX C

TECHNICAL EXHIBITS

Exhibit C-1: **Description and Use of the IWR-MAIN Utilities**

Exhibit C-2: **Description of the IWR-MAIN Execution, Batch, and Data Files**

Exhibit C-3: **IWR-MAIN System Flow Chart Diagrams**

DESCRIPTION AND USE OF IWR-MAIN UTILITIES

DATA BASE FILE

An optional data base (.PRN) file can be created to provide some facilities for graphic display or other data manipulations of the IWR-MAIN water use forecast results. If the variable name DBASE (data screen 1.1) has an input label entered then the water use forecast results will be written to a data base file with the extension .PRN.

This .PRN file can be read by most spreadsheet and data base programs. It is a standard ASCII format file which can easily be converted into a work sheet or data processing format using the appropriate software utility programs. Since this file contains no label headings, Table C-1 can be used as a guide for inserting labels to your work sheet formatted data.

DATA FILE CONVERSION UTILITIES

The data file conversion diskette contains two file conversion programs which will (1) convert a data file (without extension) generated with IWR-MAIN version 4.0 or 5.0 to a data file for use with version 5.1 and (2) convert a version 5.1 .DAT file into an unformatted data file (without extension).

To convert an old version data file for use with version 5.1, insert diskette #6 into drive A: or use the program from your hard drive. At the DOS prompt:

type CONVERT
press RETURN

The program will then ask for the filename to be converted.

type d:(filename and extension)
press RETURN

where d: is the drive specification. The program will then ask what version (4.0 or 5.0) of IWR-MAIN was used to generate the old file.

type 4 (for version 4.0) or
type 5 (for version 5.0)
press RETURN

The CONVERT utility will make the necessary conversions in the structure of the data file and save the new 5.1 version file under the same filename. The old version data file will be saved under the same filename with the extension .OLD.

The second data file conversion utility essentially reverses the Edit/Validate procedure in that it generates a data file without extension from a .DAT file. Thus, if changes have been made in the version 5.1 .DAT file with a text editor, the file may be reverted back to a data file which can be loaded into the Data Entry screens. To use this utility, insert diskette #6 into drive A: or use the program from your hard drive. At the DOS prompt:

type REVERT
press RETURN

The program will then ask for the filename of the .DAT file from which to generate the data file. You need not enter the extension (.DAT) as this is assumed. The program will reverse the formatting process and save the new data file under the same filename without an extension. If an old data file of the same name (without extension) exists, the old data file will be renamed with the extension .OLD. Thus, the .DAT file will remain unchanged, and the data file of the same name without extension will be your new data file.

EXTERNAL PROJECTION MODULE

The External Projection Module was set up as a reference data bank for use with the IWR-MAIN System. It contains county-level forecasts of population, employment (aggregate and/or disaggregate), housing units, and income. Where no county-level forecasts are available, state and regional forecasts are provided. Table C-2 presents the list of usable projections that were collected and received during a 1985 survey.

These projections are coded in a format readable by the External Projection Module. To access this module, insert Diskette #5 in drive A: or load the entire contents of the diskette onto a hard drive and type:

A > PROJECT

The user is then asked to enter a state code number (must be two digits) or a two-character state abbreviation (i.e., IL, AR, OK). Entering "QQ" terminates the Projection Module. Table C-3 lists all the states contained in the projection module, the projection type available, the state code number, and the source and publication year of the projection data.

For any selected state, the module will list the available projection types. The user has the option of viewing one of the listed projection types by entering:

"P" for population projections
"H" for housing projections
"I" for income projections
"E" for employment projections

or alternately may choose another state by entering "Q". Once a projection type has been selected, the module will indicate how many lines of data are available. If you wish to view these data, enter the range of lines you wish to examine. For example, for the state of Illinois, there are 500 lines of population projection data available. If you want to view the first 20 lines, **enter #1, #20** (or 1, 20). This will result in the first 20 lines of data to scroll across the screen. If you only wish to view the first line, **enter #1, #1**. A range must be provided, and a comma must separate the range.

If the population file is accessed in the External Projection Module, data will be presented in the following format:

R	CODE	BS	YEAR-POPULTN		YEAR-POPULTN		YEAR-POPULTN		YEAR-POPULTN		YEAR-POPULTN	
1	001 P	80	1985	0071701	1990	0074498	1995	0076228	2000	0077205	2005	0078874
1	001 P	80	2010	0079764	2015	0082155	2020	0084205	2025	0086512		
1	003 P	80	1985	0012370	1990	0012472	1995	0012619	2000	0013070	2005	0013653
1	003 P	80	2010	0014213	2015	0014698	2020	0016139	2025	0017184		

"R" specifies the aggregation level of the data such that R = 1 indicates county-level data, R = 2 indicates state-level data, and R = 3 indicates SMSA-level data. "CODE" specifies a numeric code for a county or SMSA within the selected state (see Table C-4 for a listing of select county codes). "P" indicates that the presented data are projections rather than historical data. "BS" specifies the base year of the projection data. These entries are then followed by a forecast year and its population projection. The combination of year/projection is repeated for as many years as projection data are available. Depending upon the number of projection years, data for a specific county may exceed one line.

If the housing projection file is accessed, data will be presented in the following format:

R	CODE	BS	YEAR-HOUSING		YEAR-HOUSING		YEAR-HOUSING	YEAR-HOUSING	YEAR-HOUSING
1	001 P	80	1990	0011200	2000	0012900			
1	003 P	80	1990	0119000	2000	0131400			
1	005 P	80	1990	0027600	2000	0031200			
1	007 P	80	1990	0003500	2000	0003600			

Definitions of the variables are the same as for population, except that housing units are the measured parameter.

If the income projection file is accessed, data will be presented in the following format:

R	CODE	BS	YEAR-INCME		YEAR-INCME		YEAR-INCME		YEAR-INCME		YEAR-INCME	YEAR-INCME
1	007 P	72	1985	05373	1990	06138	1995	06895	2000	07687		
1	019 P	72	1985	05221	1990	05841	1995	06563	2000	07381		
1	027 P	72	1985	04781	1990	05413	1995	06127	2000	06943		
1	031 P	72	1985	06851	1990	07663	1995	08597	2000	09391		
1	043 P	72	1985	07495	1990	08384	1995	09405	2000	10275		

Definition of these variables are the same as for population and housing, except that "BS" indicates the year of the dollar values, and personal income (in "BS" year dollar values) is the measured parameter.

If the employment projection file is accessed, data will be presented in the following format:

R	CODE	BS	YEAR	SIC-EMPLMT		SIC-EMPLMT		SIC-EMPLMT		SIC-EMPLMT		SIC-EMPLMT	
1	007 P	80	1985	0001	012318	0002	036315	1500	000056	1600	000191	1700	000116
1	007 P	80	1985	0003	005909	2000	000640	2300	000059	2400	000002	2700	000073
1	007 P	80	1985	2800	000019	3000	000178	3300	000164	3400	000146	3500	000614
1	007 P	80	1985	3700	003557	3800	000006	3900	000451	0004	000593	4700	000341
1	007 P	80	1985	4800	000236	4900	000016	0005	000300	0006	001061	0007	000401
1	007 P	80	1985	0008	001480	7200	000100	0009	001224				
1	007 P	80	1990	0001	013311	0002	000414	1500	000064	1600	000217	1700	000133
1	007 P	80	1990	0003	006538	2000	000603	2300	000063	2400	000003	2700	000077
1	007 P	80	1990	2800	000022	3000	000189	3300	000185	3400	000155	3500	000667
1	007 P	80	1990	3700	004072	3800	000007	3900	000495	0004	000623	4700	000363

Definitions of these variables are the same as for population except for "SIC-EMPLMT." Also, the projection year is only specified once per line and, therefore, any data presented on that line reflects the same specified forecast year. The disaggregation level of employment projections varied from state to state; some states project only total employment whereas others project employment by major industry sectors (construction, manufacturing, services) or by two-digit SIC codes. Therefore, for each forecast year, employment ("EMPLMT") may be provided at various disaggregation levels as defined by the codes labeled in the "SIC" category. Table C-5 provides the definitions of the "SIC" variable codes.

After a projection file has been viewed for a particular state, enter "0,0" to select another projection file. Then select another projection file to view for the state or **enter** "Q" to choose another state. At this point, enter a state code or **enter** "Q Q" to exit the projection module.

SPREADSHEET [illegible] FORMAT (filename.PRN):

Line 1-25 -- Residential results

Line 1 - Base year results

Columns 1-5 - Final category [illegible] and number of dwelling units in category; columns 2-5 are [illegible] water use and [illegible] annual water use, and maximum-day water use, respectively.

Columns 6-10 - Final [illegible] forecast [illegible] Columns as above.

Columns 11-15 - [illegible] Columns as above.

Columns 16-20 - Metered [illegible] Columns as above.

Lines 2-25 -- Forecast year results

Columns as above.

Lines 26-50 -- Nonresidential and total results

Line 26 - Base year results

Columns 1-3 - Commercial/institutional category. Column 1 is total employment in category; columns 2-3 are average annual and maximum-day water use, respectively.

Columns 4-6 - Industrial category. Column 4 is total employment in category; columns 5-6 are average annual and maximum-day water use, respectively.

Columns 7-9 - Public/[illegible] category. Column 7 unused; columns 8-9 are average annual and maximum-day water use, respectively.

Columns 10-12 - Total Municipal results. Column 10 is the calendar year; columns 11-12 are average annual and maximum-day water use, respectively.

Lines 27-50 - Forecast year results

Columns as above

*The format of lines 1-50 is repeated [illegible] forecasted water use) for lines 51-100. Note that all water use is given in gallons per day.

TABLE C-2

IWR-MAIN EXTERNAL PROJECTIONS

POPULATION	HOUSING	EMPLOYMENT	INCOME
Alabama-C	Arkansas-C	Arkansas-C	Illinois-C
Arizona-C	California-C	Delaware-C	New Mexico-C
Arkansas-C	District of Columbia-SM	District of Columbia-SM	Hawaii-C
California-C	Indiana-C	Hawaii-C	N. Carolina-ST
Colorado-C	Maryland-C	Illinois-C	
Delaware-C	Minnesota-C	Maryland-C	
District of Columbia-SM	Wisconsin-C	New Mexico-C	
Florida-C		N. Carolina-ST	
Hawaii-C		Tennessee-ST	
Illinois-C		Utah-ST	
Indiana-C			
Iowa-C			
Kentucky-C			
Louisiana-C			
Maine-C			
Maryland-C			
Minnesota-C			
Montana-C			
Nebraska-C			
Nevada-C			
New Jersey-C			
New Mexico-C			
North Carolina-C			
North Dakota-C			
Ohio-C			
Oregon-C			
Pennsylvania-C			
South Carolina-C			
Tennessee-C			
Texas-C			
Utah-C			
Vermont-C			
Virginia-C			
Washington-ST			
Wisconsin-C			

C = county SM = SMSA ST = state

TABLE C-3

INDEX FILE FOR IWR-MAIN PARAMETER PROJECTIONS

00 - DISTRICT OF COLUMBIA:

P - COOP Forecasting, Round III Technical Report - 1984. Sent by Metropolitan Policy Program, Metropolitan Washington Council of Governors.

H - COOP Forecasting, Round III Technical Report - 1984. Sent by Metropolitan Policy Program, Metropolitan Council of Governors.

E - COOP Forecasting, Round III Technical Report - 1984. Sent by Metropolitan Policy Program, Metropolitan Council of Governors.

01 - ALABAMA:

P - Standard Population Projections: Alabama Counties - 1983. By Department of Economic and Community Affairs, Montgomery, Alabama 36130.

04 - ARIZONA:

P - Arizona Department of Economic Security, Population Statistics Unit - 1984.

05 - ARKANSAS:

P - Arkansas Population Projections to 1990, by County: Research Memorandum. By Industrial Research Center, University of Arkansas.

H - Projections for Jefferson County. By Southeast Arkansas Regional Planning Commission, Pine Bluff.

E - Projections for Jefferson County. By Southeast Arkansas Regional Planning Commission, Pine Bluff.

06 - CALIFORNIA:

P - California Population Projections: Report 83 P-1, Population Research Unit, 1025 P Street, Sacramento, California. 1983.

H - Household Projections for California Counties, Population Research Unit, 1025 P Street, Sacramento, California. 1984.

08 - COLORADO:

P - Printout. Demographic Section of the Colorado Division of Local Governments. Department of Local Affairs, Denver, CO.

10 - DELAWARE:

P - Delaware Population Consortium. Sent by Delaware Development Office, Dover.

E - College of Urban Affairs and Public Policy. Sent by Delaware Development Office, Dover.

12- FLORIDA:

P - 1980 Base Year, Population Projection (low estimate), Executive Office of Governor, Tallahassee.

TABLE C-3 (Continued)

15 - HAWAII:

P - Population and Economic Projections for Hawaii, 1980-2005. By the Department of Planning and Economic Development. 1984.

E - Employment Projections. By Department of Planning and Economic Development. 1984.

17 - ILLINOIS:

P - Illinois Population Trends 1970-2025. Bureau of the Budget. 1984.

E - Employment Projections. Bureau of the Budget. 1984

I - Economic Projections. Bureau of the Budget. 1984.

18 - INDIANA:

P - Indiana Business Review, Volume 58, 1983.

H - Indiana Business Review, Volume 65, 1984.

19 - IOWA:

P - Population Projections. By Office of State Demographer, Office for Planning and Management. 1984.

21 - KENTUCKY:

P - How Many Kentuckians: Population Forecast, 1980-2020. 1984. By Urban Studies Center, College of Urban and Public Affairs, University of Louisville.

22 - LOUISIANA:

P - Middle - Population Projections. By University of New Orleans, Division of Business and Economic Research.

23 - MAINE:

P - Population Projections. By Bureau of Health, Planning and Development. 1984.

24 - MARYLAND:

P - Population Projections 1980-2000, Report 1, 1984. By Maryland Department of State Planning.

H - Projections of Housing Demand, Number, and Size. By Maryland Department of State Planning. 1984.

E - Employment in Maryland, Trends and Projections 1967-2000. By Maryland Department of State Planning. 1984.

27 - MINNESOTA:

P - Population Notes, Minnesota. Department of Energy and Planning. 1982.

H - Low-Estimate Housing Projections. By State Demography Unit, Minnesota State Planning Agency. 1983.

TABLE C-3 (Continued)

30 - MONTANA:
- P - Montana County Population Projections. By Census and Economic Information Center, Montana Department of Commerce. 1983.

31 - NEBRASKA:
- P - County Projections (Medium Series). By Bureau of Business Research, University of Nebraska-Lincoln. 1982.

32 - NEVADA:
- P - Population Projections. By Bureau of Business and Business and Economic Research. 1983.

34 - NEW JERSEY:
- P - Revised Total and Age and Sex Population Projections 1985-2000. By Office of Demographic and Economic Analysis, Department of Labor, Trenton, NJ. 1983.

35 - NEW MEXICO:
- P - Population Projections. By Bureau of Business and Economic Research, Institute for Applied Research Services. 1983.
- E - Employment Projections. By Bureau of Business and Economic Research, University of New Mexico. 1983.
- I - Economic Projections. By Bureau of Business and Economic Research, University of New Mexico. 1983.

37 - NORTH CAROLINA:
- P - Population Projections. By North Carolina Long-Term Economic-Demographic Projection 1985. Office of State Budget and Management.
- E - State Employment Projections. By Office of State Budget and Management. 1984.

38 - NORTH DAKOTA:
- P - Population Projections (Low Estimate). By AG Economics Statistical Series. Issue No. 39. 1982.

39 - OHIO:
- P - Ohio Data Center, Department of Development. 1983.

41 - OREGON:
- P - Population Projections: Oregon and Counties: 1980-2000. By School of Urban and Public Affairs, Portland State University. 1983.

42 - PENNSYLVANIA:
- P - 1970, 80, 90 Population by Sex and Age: County Detail. By Department of Health, State Health Data Center, 1984.

TABLE C-3 (Continued)

45 - SOUTH CAROLINA:
- P - Population Projections by County: 1985-2000. By South Carolina State Data Center. 1984.

47 - TENNESSEE:
- P - Population Projections (Low Projection-Series #3). By Department of Sociology, University of Tennessee, Knoxville. 1983.
- E - State Employment Projections. By Tennessee Employment Projections 1984-1990. 1984.

48 - TEXAS:
- P - Population and Projections for the State of Texas 1970-2000. By Texas Department of Water Resources. 1982.

49 - UTAH:
- P - Utah Base-Line Provisional Population Projections Table 9. 1983.
- E - State Employment Projections. Utah Process Economic & Demographic Projections. 1984.

50 - VERMONT:
- P - Vermont Population Projections: 1985-2000. By Vermont Department of Health, State Planning Office. 1983.

51 - VIRGINIA:
- P - Virginia Population Projections to 2000. By Department of Planning and Research, Richman, VA. 1983.

53 - WASHINGTON:
- P - Forecasts of State Population by Sex and Age: 1985-2010. 1984.

55 - WISCONSIN:
- P - Projections of Population. By Demographic Services Center, Wisconsin Department of Administration. 1983.
- H - Projected Total Households. By Demographic Services Center, Department of Administration. 1984.

P = population, E = employment, H = housing, and I = income

Note that Washington D.C. was the only SMSA forecast and therefore has a state code of "00".

TABLE C-4

INDEX OF SELECT STATE AND COUNTY CODES

ALABAMA					
01	003	Baldwin	01	097	Mobile
01	051	Elmore	01	101	Montgomery
01	055	Etowah	01	113	Russell
01	073	Jefferson	01	117	Shelby
01	083	Limestone	01	125	Tuscaloosa
01	089	Madison	01	127	Walker
ARIZONA					
04	013	Maricopa	04	019	Pima
ARKANSAS					
05	033	Crawford	05	119	Pulaski
05	035	Crittenden	05	125	Saline
05	069	Jefferson	05	131	Sebastian
05	091	Miller			
CALIFORNIA					
06	001	Alameda	06	071	San Bernardino
06	013	Contra Costa	06	073	San Diego
06	019	Fresno	06	073	San Francisco
06	029	Kern	06	077	San Joaquin
06	037	Los Angeles	06	081	San Mateo
06	041	Marin	06	083	Santa Barbara
06	053	Monterey	06	085	Santa Clara
06	055	Napa	06	095	Solano
06	059	Orange	06	097	Sonoma
06	061	Placer	06	099	Stanislaus
06	065	Riverside	06	111	Ventura
06	067	Sacramento	06	113	Yolo
COLORADO					
08	001	Adams	08	041	El Paso
08	005	Arapahoe	08	059	Jefferson
08	013	Boulder	08	101	Pueblo
08	031	Denver			
CONNECTICUT					
09	001	Fairfield	09	007	Middlesex
09	003	Hartford	09	009	New Haven
09	005	Litchfield	09	013	Tolland
DELAWARE					
10	003	New Castle			

TABLE C-4 (Continued)

FLORIDA					
12	001	Alachua	12	073	Leon
12	011	Broward	12	095	Orange
12	025	Dade	12	099	Palm Beach
12	031	Duval	12	103	Pinellas
12	033	Escambia	12	113	Santa Rosa
12	057	Hillsborough	12	117	Seminole
GEORGIA					
13	021	Bibb	13	095	Dougherty
13	051	Chatham	13	121	Fulton
13	053	Chattahoochee	13	135	Gwinnett
13	063	Clayton	13	153	Houston
13	067	Cobb	13	510	Columbus City
13	089	De Kalb	13	245	Richmond
HAWAII					
15	003	Honolulu			
IDAHO					
16	001	Ada			
ILLINOIS					
17	007	Boone	17	119	Madison
17	019	Champaign	17	143	Peoria
17	031	Cook	17	163	St Clair
17	042	Du Page	17	167	Sangamon
17	089	Kane	17	179	Tazewell
17	111	McHenry	17	197	Will
17	113	McLean	17	201	Winnebago
17	115	Macon	17	203	Woodford
INDIANA					
18	003	Allen	18	099	Marshall
18	011	Boone	18	097	Marion
18	019	Clark	18	109	Morgan
18	021	Clay	18	127	Porter
18	029	Dearborn	18	141	St Joseph
18	035	Delaware	18	145	Shelby
18	043	Floyd	18	153	Sullivan
18	057	Hamilton	18	157	Tippecanoe
18	059	Hancock	18	163	Vanderburgh
18	063	Hendricks	18	165	Vermillon
18	081	Johnson	18	167	Vico
18	089	Lake	18	173	Warrick
18	095	Madison			
IOWA					
19	013	Black Hawk	19	155	Pottawattamie
19	061	Dubuque	19	193	Woodbury
19	153	Polk			

TABLE C-4 (Continued)

KANSAS					
20	015	Butler	20	177	Shawnee
20	091	Johnson	20	209	Wyandotte
20	173	Sedgwick			
KENTUCKY					
21	015	Boone	21	101	Henderson
21	019	Boyd	21	111	Jefferson
21	037	Campbell	21	117	Kenton
21	067	Fayette			
LOUISIANA					
22	015	Bossier	22	055	Lafayette
22	017	Caddo	22	071	Orleans
22	019	Calcasieu	22	073	Ouachita
22	033	East Baton Rouge	22	087	St Bernard
22	051	Jefferson	22	103	St Tammany
MAINE					
23	001	Androscoggin	23	005	Cumberland
MARYLAND					
24	003	Anne Arundel	24	027	Howard
24	005	Baltimore	24	031	Montgomery
24	013	Carroll	24	033	Prince Georges
24	015	Cecil	24	510	Baltimore City
24	025	Harford			
MASSACHUSETTS					
25	003	Bermshire	25	017	Middlesex
25	005	Bristol	25	021	Norfolk
25	009	Essex	25	023	Plymouth
25	013	Hampden	25	027	Worcester
25	015	Hampshire			
MICHIGAN					
26	017	Bay	26	099	MacComb
26	037	Clinton	26	115	Monroe
26	045	Eaton	26	121	Muskegon
26	049	Genessee	26	125	Oakland
26	065	Ingham	26	139	Ottawa
26	075	Jackson	26	145	Saginaw
26	077	Kalamazoo	26	161	Washtenaw
26	081	Kent	26	163	Wayne
26	087	Lapeer			
MINNESOTA					
27	003	Anoka	27	109	Olmsted
27	027	Clay	27	123	Ramsey
27	037	Dakota	27	137	St Louis
27	053	Hennepin	27	163	Washington

TABLE C-4 (Continued)

MISSISSIPPI					
28	047	Harrison	28	121	Rankin
28	049	Hines			
MISSOURI					
29	019	Boone	29	095	Jackson
29	021	Buchanan	29	099	Jefferson
29	037	Cass	29	165	Platte
29	047	Clay	29	183	St Charles
29	071	Franklin	29	189	St Louis
29	077	Greene	29	510	St Louis City
MONTANA					
30	013	Cascade	30	111	Yellowstone
NEBRASKA					
31	043	Dakota	31	109	Lancaster
31	055	Douglas	31	153	Sarpy
NEVADA					
32	003	Clark	32	031	Washoe
NEW HAMPSHIRE					
33	011	Hillsborough	33	015	Rockingham
33	013	Merrimack			
NEW JERSEY					
34	001	Atlantic	34	017	Hudson
34	003	Bergen	34	021	Mercer
34	005	Burlington	34	027	Morris
34	007	Camden	34	031	Passaic
34	011	Cumberland	34	033	Salem
34	013	Essex	34	039	Union
34	015	Gloucester	34	041	Warren
NEW MEXICO					
35	001	Bernalillo			
NEW YORK					
36	001	Albany	36	073	Orleans
36	005	Bronx	36	075	Oswego
36	007	Broome	36	081	Queens
36	029	Erie	36	083	Rensselaer
36	043	Herkimer	36	085	Richmond
36	047	Kings	36	087	Rockland
36	051	Livingston	36	091	Saratoga
36	053	Madison	36	093	Schenectady
36	055	Monroe	36	103	Suffolk
36	059	Nassau	36	107	Tioga
36	061	New York	36	117	Wayne
36	063	Niagara	36	119	Westchester
36	065	Oneida			

TABLE C-4 (Continued)

NORTH CAROLINA					
37	019	Brunswick	37	129	New Hanover
37	021	Buncombe	37	135	Orange
37	051	Cumberland	37	151	Randolph
37	063	Durham	37	179	Union
37	067	Forsyth	37	183	Wake
37	067	Guilford	37	197	Yadkin
37	119	Mecklenberg			
NORTH DAKOTA					
38	017	Cass			
OHIO					
39	003	Allen	39	099	Mahoning
39	013	Belmont	39	103	Medina
39	017	Butler	39	109	Miami
39	023	Clark	39	113	Montgomery
39	025	Clermont	39	129	Pickaway
39	035	Cuyahoga	39	133	Portage
39	041	Delaware	39	135	Preble
39	049	Franklin	39	137	Putnam
39	055	Geauga	39	139	Richland
39	057	Greene	39	151	Stark
39	061	Hamilton	39	153	Summit
39	081	Jefferson	39	155	Trumbull
39	085	Lake	39	161	Van Wert
39	087	Lawrence	39	165	Warren
39	093	Lorain	39	173	Wood
39	095	Lucas			
OKLAHOMA					
40	017	Canadian	40	109	Oklahoma
40	027	Cleveland	40	113	Osage
40	031	Comanche	40	135	Sequoyah
40	037	Creek	40	143	Tulsa
40	079	Le Flore			
OREGON					
41	005	Clackamas	41	051	Multnomah
41	039	Lane	41	053	Polk
41	047	Marion			
PENNSYLVANIA					
42	001	Adams	42	071	Lancaster
42	003	Allegheny	42	077	Lehigh
42	007	Beaver	42	079	Luzerne
42	011	Berks	42	091	Montgomery
42	013	Blair	42	095	Northampton
42	017	Bucks	42	099	Perry
42	021	Cambria	42	101	Philadelphia
42	029	Chester	42	111	Somerset

TABLE C-4 (Continued)

42	041	Cumberland	42	115	Susquehanna
42	043	Dauphin	42	125	Washington
42	045	Delaware	42	129	Westmoreland
42	049	Erie	42	133	York
42	069	Lackawanna			
RHODE ISLAND					
44	001	Bristol	44	007	Providence
44	003	Kent	44	009	Washington
44	005	Newport			
SOUTH CAROLINA					
45	003	Aiken	45	045	Greenville
45	015	Berkeley	45	077	Pickens
45	019	Charleston			
SOUTH DAKOTA					
46	099	Minnehaha			
TENNESSEE					
47	001	Anderson	47	157	Shelby
47	009	Blount	47	165	Sumner
47	037	Davidson	47	189	Wilson
47	093	Knox			
TEXAS					
48	009	Archer	48	257	Kaufman
48	029	Bexar	48	291	Liberty
48	037	Bowie	48	303	Lubbock
48	039	Brazoria	48	309	McClennan
48	041	Brazos	48	329	Midland
48	061	Cameron	48	339	Montgomery
48	085	Collin	48	355	Nueces
48	113	Dallas	48	361	Orange
48	121	Denton	48	375	Potter
48	135	Ector	48	381	Randall
48	139	Ellis	48	397	Rockwall
48	141	El Paso	48	409	San Patricio
48	157	Fort Bend	48	423	Smith
48	167	Galveston	48	439	Tarrant
48	181	Grayson	48	441	Taylor
48	201	Harris	48	451	Tom Green
48	215	Hidalgo	48	453	Travis
48	245	Jefferson	48	479	Webb
48	251	Johnson	48	485	Wichita
48	253	Jones			
UTAH					
49	011	Davis	49	049	Utah
49	035	Salt Lake	49	057	Weber

TABLE C-4 (Continued)

VIRGINIA					
51	009	Amherst	51	550	Chesapeake City
51	013	Arlington	51	600	Fairfax City
51	031	Campbell	51	610	Falls Church City
51	041	Chesterfield	51	650	Hampton City
51	059	Fairfax	51	680	Lynchburg City
51	085	Hanover	51	700	Newport News City
51	087	Henrico	51	710	Norfolk City
51	107	Loudon	51	740	Portsmouth City
51	153	Prince William	51	760	Richmond City
51	161	Roanoke	51	770	Roanoke City
51	199	York	51	775	Salem City
51	510	Alexandria City	51	810	Virginia Beach City
WASHINGTON					
53	011	Clark	53	061	Snohomish
53	033	King	53	063	Spokane
53	053	Pierce			
WEST VIRGINIA					
54	009	Brooke	54	051	Marshall
54	011	Cabell	54	069	Ohio
54	029	Hancock	54	099	Wayne
54	039	Kanawha			
WISCONSIN					
55	009	Brown	55	087	Outagamie
55	015	Calumet	55	089	Ozaukee
55	031	Douglas	55	101	Racine
55	059	Kenosha	55	133	Waukesha
55	079	Milwaukee	55	139	Winnebago
DISTRICT OF COLUMBIA					
00	001	Washington			

For a complete listing of state, county, and SMSA codes, see County and City Data Book published by the U.S. Bureau of the Census.

TABLE C-5

EMPLOYMENT CODES/SIC CATEGORIES FOR THE EMPLOYMENT FILE OF THE EXTERNAL PROJECTION MODULE

Codes	Definition
0001	Total employment
0002	Total construction employment (SIC 1500-1799)
0003	Total manufacturing employment (SIC 2000-3999)
0004	Total TCU employment (SIC 4000-4999)
0005	Total wholesale employment (SIC 5000-5199)
0006	Total retail employment (SIC 5200-5999)
0007	Total finance employment (SIC 6000-6799)
0008	Total services employment (SIC 7000-8999)
0009	Local government employment
0100	Agricultural projection--crops
0200	Agricultural production--livestock
0700	Agricultural services
0800	Forestry
0900	Fishing, hunting, and trapping
1000	Metal mining
1100	Anthracite mining
1200	Bituminous coal and lignite mining
1300	Oil and gas extraction
1400	Nonmetallic minerals, except fuels
1500	General building contractors
1600	Heavy construction contractors
1700	Special trade contractors
2000	Food and kindred products
2100	Tobacco manufactures
2200	Textile mill products
2300	Apparel and other textile products
2400	Lumber and wood products
2500	Furniture and fixtures
2600	Paper and allied products
2700	Printing and publishing
2800	Chemicals and allied products
2900	Petroleum and coal products
3000	Rubber and miscellaneous plastics products
3100	Leather and leather products
3200	Stone, clay, and glass products
3300	Primary metal industries
3400	Fabricated metal products
3500	Machinery, except electrical
3600	Electric and electronic equipment
3700	Transportation equipment
3800	Instruments and related products
3900	Miscellaneous manufacturing industries

TABLE C-5 (Continued)

Codes	Definition
4000	Railroad transportation
4100	Local and interurban passenger transit
4200	Trucking and warehousing
4300	U.S. postal service
4400	Water transportation
4500	Transportation by air
4600	Pipe lines, except natural gas
4700	Transportation services
4800	Communication
4900	Electric, gas, and sanitary services
5000	Wholesale trade--durable goods
5100	Wholesale trade--nondurable goods
5200	Building materials and garden supplies
5300	General merchandise stores
5400	Food stores
5500	Automotive dealers and service stations
5600	Apparel and accessory stores
5700	Furniture and home furnishings stores
5800	Eating and drinking places
5900	Miscellaneous retail
6000	Banking
6100	Credit agencies other than banks
6200	Security, commodity brokers, and services
6300	Insurance carriers
6400	Insurance agents, brokers, and service
6500	Real estate
6600	Combined real estate, insurance, etc.
6700	Holding and other investment offices
7000	Hotels and other lodging places
7200	Personal services
7300	Business services
7500	Auto repair, services, and garages
7600	Miscellaneous repair services
7800	Motion pictures
7900	Amusement and recreation services
8000	Health services
8100	Legal services
8200	Educational services
8300	Social services
8400	Museums, botanical, zoological gardens
8600	Membership organizations
8800	Private households
8900	Miscellaneous services

EXHIBIT C-2

DESCRIPTION OF IWR-MAIN EXECUTION, BATCH, AND DATA FILES

This exhibit provides brief descriptions of the IWR-MAIN System and data files. In addition, a cross-reference between the data entered in the Data Entry screens and converted data subgroups and labels appearing in the .DAT file is also included.

BATCH FILES

IWRMAIN.BAT - Main calling routine. It brings up the Main Menu and thereafter controls all major options (i.e., Edit/Validate, Print/View). For use with floppy diskettes, it should be on the first four IWR-MAIN diskettes.

MENU.BAT - Called initially by IWRMAIN.BAT. Used internally to return to Main Menu. It also should be on the first four IWR-MAIN diskettes.

CALL.RESP.BAT - Used internally to direct control to various modules. This is an empty file which is created and deleted by IWR-MAIN as needed.

INSTALL.BAT - Installs IWR-MAIN 5.1 onto a hard drive and creates a subdirectory MAIN51. It should be on all IWR-MAIN diskettes.

EXECUTABLE FILES

MENU51.EXE, REFORM51.EXE, RFUSLB51.EXE, DATENT51.EXE, EDIT51.EXE, and MERGE51.EXE - Compiled versions of C source programs written for PC use. These routines perform data entry, checking and editing, reformatting, displaying of menus, etc.

MAIN51.EXE - Compiled version of FORTRAN source programs which contain the computational routines of the Run Model procedure.

PRINT51.EXE - Compiled version of FORTRAN source program for displaying and printing reports.

HELP FILES

HELP51.HLP - Text help file used by C language routines to display on-line help messages.

SCRLST51.HLP - Text help file used by C language to display list of screens for Data/Entry.

PRINT51.HLP - Text help file used by PRINT51.EXE.

LIBRARY FILES

COFLB51 - Library of Water Use Coefficients.

FLONLAT - Library of Climatic Variables. Contains values of RAIN and EVAP variables for specific longitudes and latitudes throughout the contiguous (48) United States.

LCC - Library of Conservation Coefficients. Contains values for reduction factors, parameter factors to calculate coverage factors, and interaction factors.

MISCELLANEOUS FILES

MAINSYS.CTL - Holds name of data file last used; written and deleted by MENU51.EXE.

PROJD - Temporary file created to store parameter projections by the GROWTH subroutine in the MAIN51.EXE module. This file is created and deleted during the Run Model procedure. When using diskettes, this file is written to diskette #4.

DATA FILES

(filename).(no extension) - Unformatted source data file created by DATENT51.EXE.

(filename).DAT - Formatted data file created by REFORM51.EXE and read by MAIN51.EXE.

(filename).ULB - User's specified library, created by RFUSLB51.EXE when ever additional categories are specified.

(filename).WOR - Working library created by RFUSLB51.EXE and MERGE51.EXE. It is a copy of COFLB51 merged with user-specified (.ULB) values (if any).

(filename).COV - Conservation output file containing coverage factors and effectiveness of individual conservation measures. Created during MAIN51.EXE when conservation data are present.

(filename).RPx - Report files Contains IWR-MAIN water use reports created by MAIN51.EXE for each year. Base year output is a .RP1, first forecast year is .RP2, etc.

(filename).MAT - Matrix index file. Used by the PRINT51.EXE module to list and locate report numbers.

(filename).PRN - Data base file. Created whenever user specifies the option and contains results of the water use forecast which can be used with spreadsheet and database software.

(filename).WRK - Temporary file used by PRINT51.EXE to search and display the reports.

DESCRIPTION OF THE .DAT DATA FILE

During the Edit/Validate procedure, the data entered in the IWR-MAIN data screens are converted into a structured ASCII format (.DAT file). This file is used during the Run Model procedure and is scrolled on the screen during the REDINPUT routine. Therefore, the user should be somewhat familiar with not only the structure of this .DAT file but the labels and subgroups as well.

When all possible options are selected, the data will be structured and labeled under the following major subgroups (labels of data within a subgroup are underlined):

CITYDATA-- subgroup containing the study area name, base year, general municipal data (screens 1.1 and 1.2).
CCOD-- indicates that a central business district is included in the study area

DBAS -- supplying this variable name with a value of one causes results, disaggregated by sector and season, to be printed to an external file with extension .PRN. This file can be read by spreadsheet programs (optional).

CDAT -- calendar year for base year estimate

LATD -- latitude of study area

LONG -- longitude of study area

POPU -- study area resident population

ICOM -- median household income

CCBN -- U.S. Dept. of Commerce National Composite Construction Cost Index for base year; if CCBN is omitted, CCAL and CCBL must be provided (index base for CCBN is 1977; 1980 = 143.3)

CCAL -- 1980 value of any appropriate alternative cost or price index; required only if CCBN not provided

CCBL -- base year value of index used for CCAL; required only if CCBN not provided

EVAP -- summer season potential evapotranspiration (optional)

RAIN -- mean precipitation (optional)

EVMX -- maximum-day potential evapotranspiration in inches (optional)

EVNT -- summer season moisture deficit in inches (optional)

SVPA -- actual summer potential evapotranspiration, for verification purposes (optional)

SRNA -- actual summer precipitation, for verification purposes (optional)

SMDA -- actual summer moisture deficit, for verification purposes (optional)

ICO1 -- fraction of households with base year income less than $10,000 expressed in 1980 dollars (optional)

ICO2 -- fraction of households with base year income at least $10,000, but not more than $20,000 expressed in 1980 dollars (optional)

ICO3 -- fraction of households with base year income at least $20,000, but not more than $30,000 expressed in 1980 dollars (optional)

EMP1, EMT5 -- total study area employment during base year and five years prior to base year respectively

EMP2, EM25 -- employment in construction industries for base year and five years prior to base year, respectively (optional)

EMP3, EM35 -- employment in manufacturing industries for base year and five years prior to base year, respectively (optional)

EMP4, EM45 -- employment in transportation, communications, and utilities industries for base year and five years prior to base year, respectively (optional)

EMP5, EM55 -- employment in wholesale trade for base year and five years prior to base year, respectively (optional)

EMP6, EM65 -- employment in retail trade for base year and five years prior to base year, respectively (optional)

EMP7, EM75 -- employment in finance industries for base year and five years prior to base year, respectively (optional)

EMP8, EM85 -- employment in service industries for base year and five years prior to base year (optional)

EMP9, EM95 -- employment in government for base year and five years prior to base year (optional)

Residential data are structured into four major subgroups:

FLATSEWR -- subgroup containing flat rate and sewered units (screens 2.1 and 2.2)

FLATSEPT -- subgroup contains flat rate and unsewered units (screens 3.1 and 3.2)

METRSEWR -- subgroup containing metered and sewered units (screens 4.1 and 4.2)

APARTMNT -- subgroups containing master-metered apartment units (screens 5.1 and 5.2)

Data labels for these subgroups include:

VALN -- lower limit of property value range
VALX -- upper limit of property value range
PEPL -- persons per household (for all subgroups except METERSEWR)
ASMT -- housing assessment factor for value ranges if using assessed valuation rather than market value (optional)
DENS -- housing density, dwelling units per acre (for all subgroups except APARTMNT)
NUMB -- number of housing units
ANPR -- annual marginal price of water and wastewater services (only METRSEWR)
SMPR -- summer marginal price of water and wastewater services (only METRSEWR)
DIFA -- annual bill difference variable (only METERSEWR)
DIFS -- summer bill difference variable (only METERSEWR)

Commercial/institutional and industrial data are structured within three major subgroups:

COMMEMPL -- subgroup containing commercial employment (screen 6.1)
COMMPARM -- subgroup containing commercial parameters (screens 6.2 and 6.3)
INDPARM -- subgroup containing industrial employment (screens 7.1 through 7.7)

Categories within these subgroups include:

C001 to C050 -- commercial/institutional categories
I001 to I200 -- industrial categories

Marginal nonresidential prices are in the subgroup:

NRPRICES -- subgroup containing nonresidential prices
CPRB -- marginal price of water for commercial establishments in base year
CPRC -- marginal price of water for commercial establishments in year concurrent with commercial water use coefficients
IPRB -- marginal price of water for industrial establishments in base year
IPRC -- marginal price of water for industrial establishments in year concurrent with industrial water use coefficients

Public/Unaccounted data are contained in the following three subgroups:

PUBPARAM -- using parameters and coefficients contained in the library to calculate LOSS and FSER water use (screen 8.1)
PUBANAVE and
PUBMAXDY -- subgroups containing user-specified water use in gallons per day or gallons per day per unit (screens 8.1 and 8.2)

Within these subgroups the data categories include:

LOSS -- distribution losses (can be calculated by parameters or direct estimates of water use)
FSER -- free service water use (can be calculated by parameters or direct estimates of water use)
P001 to
P027 -- user-specified public categories (only calculated by direct estimates of water use)

The following subgroup appears if the conservation option is used:

CONSERVE -- subgroup containing key conservation parameters
NMEASURES -- number of measures selected
YEARS -- (two lines) year of initiation of measure; nine positions per line, each position corresponds with specific measure (screen 15.1)

SECTORS -- (one line for each selected measure) indicates selected sector for given measure, seven positions per line, each position corresponds with specific sector (screen 15.2)

REDUCTION FACTORS and
COVERAGE FACTORS -- "L" indicates all values obtained from library, "S" indicates some or all values specified

FORECAST YEARS -- number of forecast years, from Parameter Control Screen

Reduction or coverage factor data, if specified (S), include:

DIMENSION -- 1 = indoor use, 2 = outdoor use, 3 = maximum-day use
MEASURE -- specific measure (1-18 from screen 15.1)
SECTOR -- specific sector (1-7 from screen 15.2)
VALUE -- reduction factor or coverage factor as indicated by REDFACT or COVFACT, respectively
YEAR -- 00 = base year, 1 = first forecast year, 2 = second forecast year, etc.

Each forecast year is specified by the appearance of the subgroup:

NEWYEAR -- subgroup containing key projections of water parameters

Within every NEWYEAR subgroup the following data categories will be present:

YEAR -- calendar year of water use forecast
POPU -- total resident population in study area
ICOM -- median household income
EMPL -- total study area employment
HTOT -- total number of housing units (optional)
ICO1 -- fraction of households with forecast year income less than $10,000 expressed in 1980 dollars (optional)
ICO2 -- fraction of households with forecast year income at least $10,000, but not more than $20,000 expressed in 1980 dollars (optional)
ICO3 -- fraction of households with forecast year income at least $20,000, but not more than $30,000 expressed in 1980 dollars (optional)
EMP2 -- employment in construction industries (optional)
EMP3 -- employment in manufacturing industries (optional)
EMP4 -- employment in TCU industries (optional)
EMP5 -- employment in wholesale trade (optional)
EMP6 -- employment in retail trade (optional)
EMP7 -- employment in finance industries (optional)
EMP8 -- employment in service industries (optional)
EMP9 -- employment in government (optional)

Historical data, if provided, will be contained within the following subgroups:

HNUMHOMS -- historical residential data, number of housing units in specified category and value range group (see combinations below under NUMHOMES)
HCOMPARM -- historical commercial parameter, category specified by C0xx
HINDPARM -- historical industrial parameter, category specified by Ixxx
HPUBPARM -- historical public/unaccounted parameter, category specified by LOSS, FSER, or P0xx

Parameters within each of these subgroups are listed by year:

YEAR -- calendar year of data points immediately following

Residential housing projections will be included within the following subgroup:

NUMHOMES -- subgroup containing external housing projections

Data within this subgroup are given for a specific combination of category and value range group (e.g., MWG4, APTL):

FW -- flat rate and sewered
FP -- flat rate and unsewered
MW -- metered and sewered
AP -- apartment
G1 -- value range group one (no. units)
G2 -- value range group two (no. units)
G3 -- value range group three (no. units)
G4 -- value range group four (no. units)
TL -- Total (no. units)

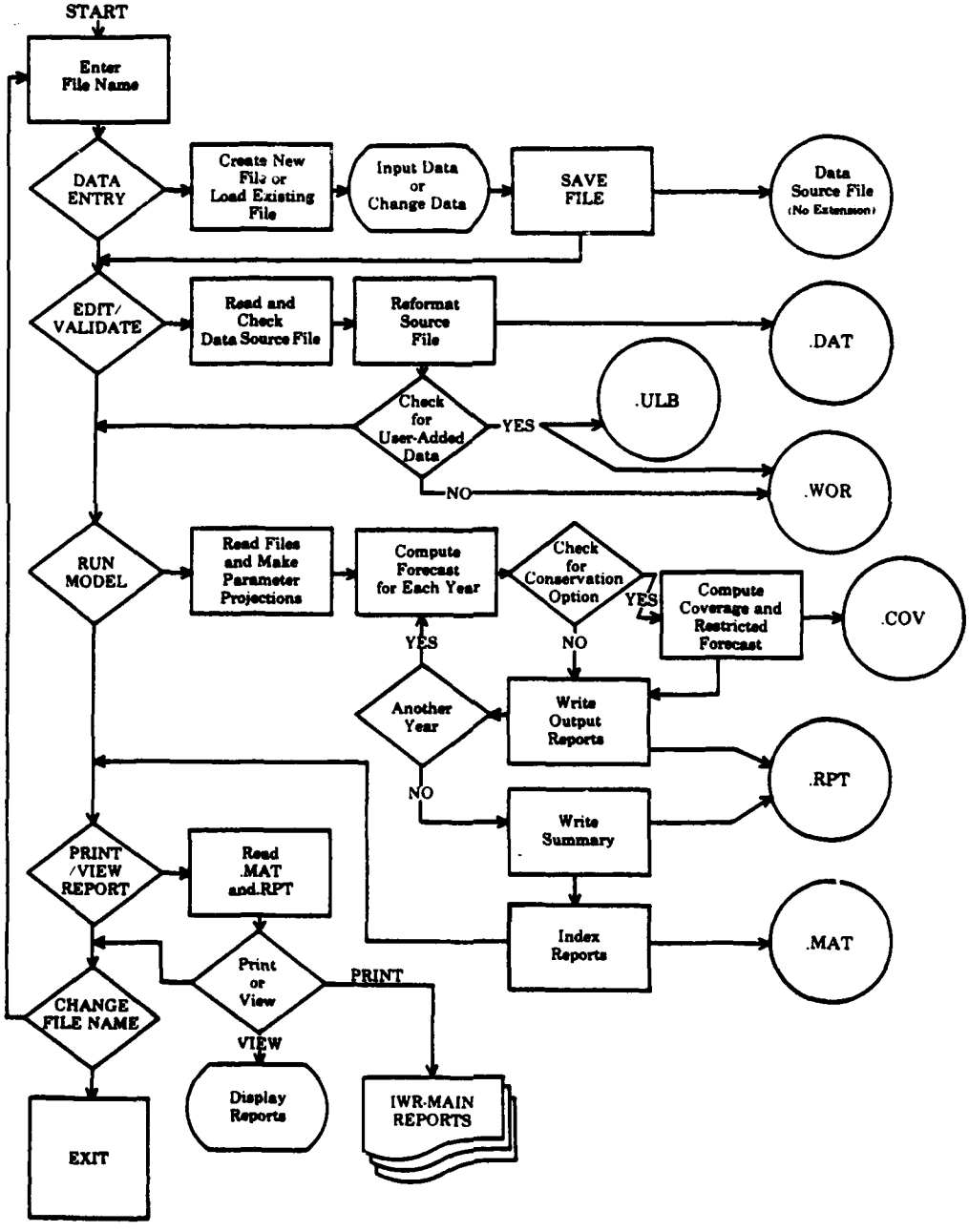
Nonresidential projections will be included within the following subgroups:

COMFPARM -- subgroup of external commercial parameter projections, category specified by COxx
COMFEMPL -- subgroup of external commercial employment projections, category specified by COxx
INDPROJT -- subgroup of external industrial employment projections, category specified by Ixxx
PUBANAVE and PUBMAXDY -- subgroups of external public/unaccounted water use in specified categories, category specified by LOSS, FSER, or POxx

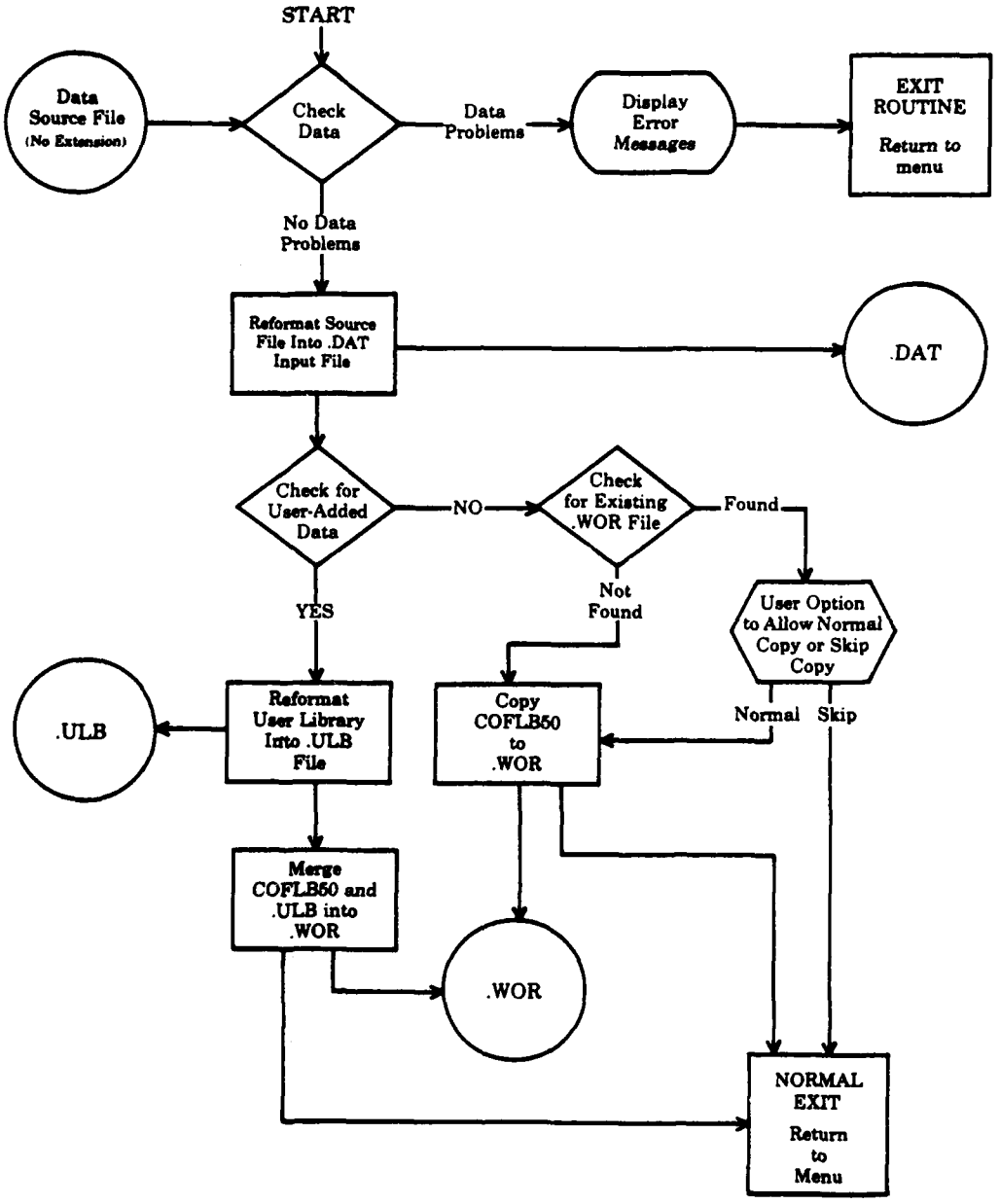
EXHIBIT C-3

IWR-MAIN SYSTEM FLOW CHART DIAGRAMS

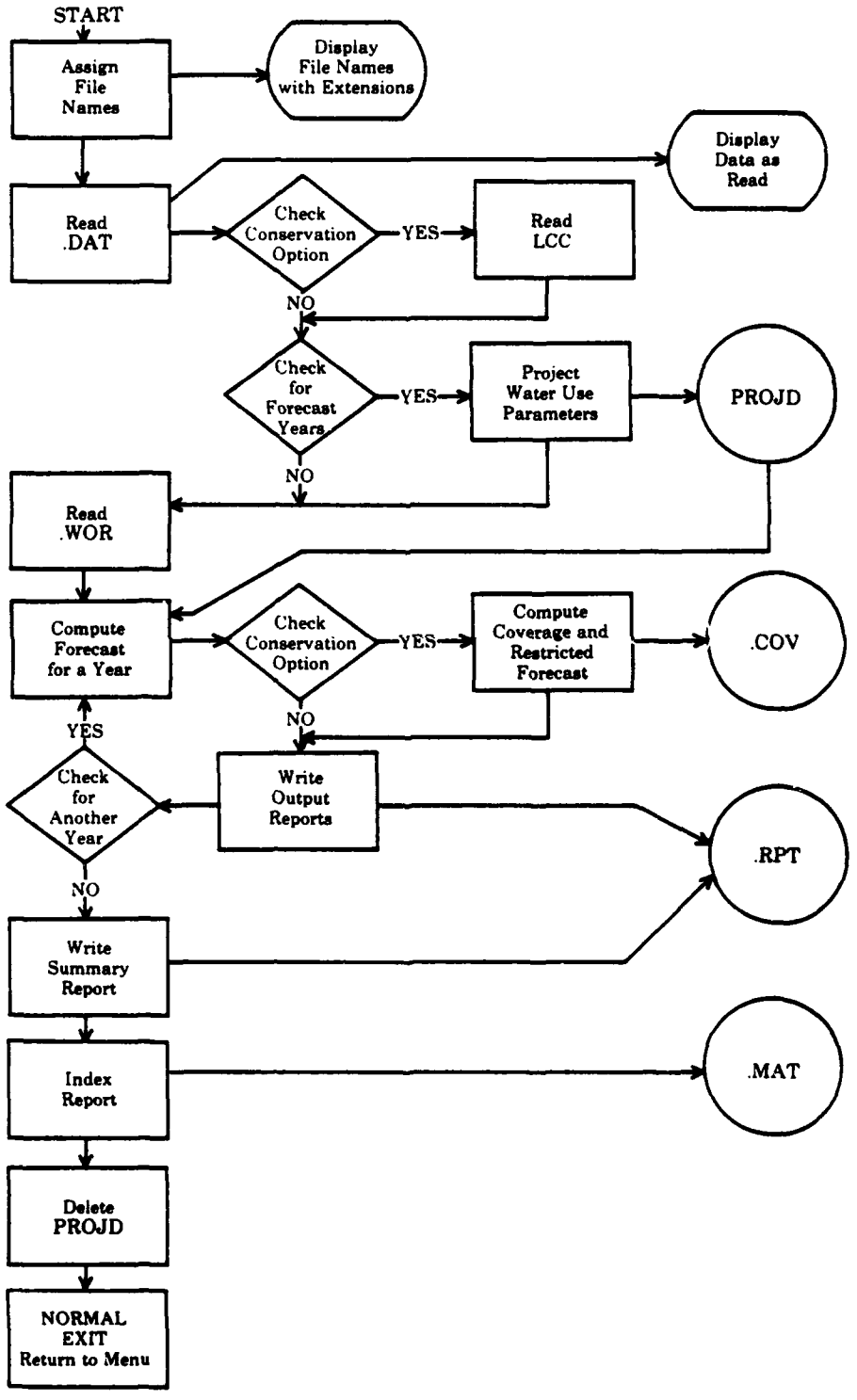
SIMPLIFIED FLOW CHART OF IWR-MAIN SYSTEM



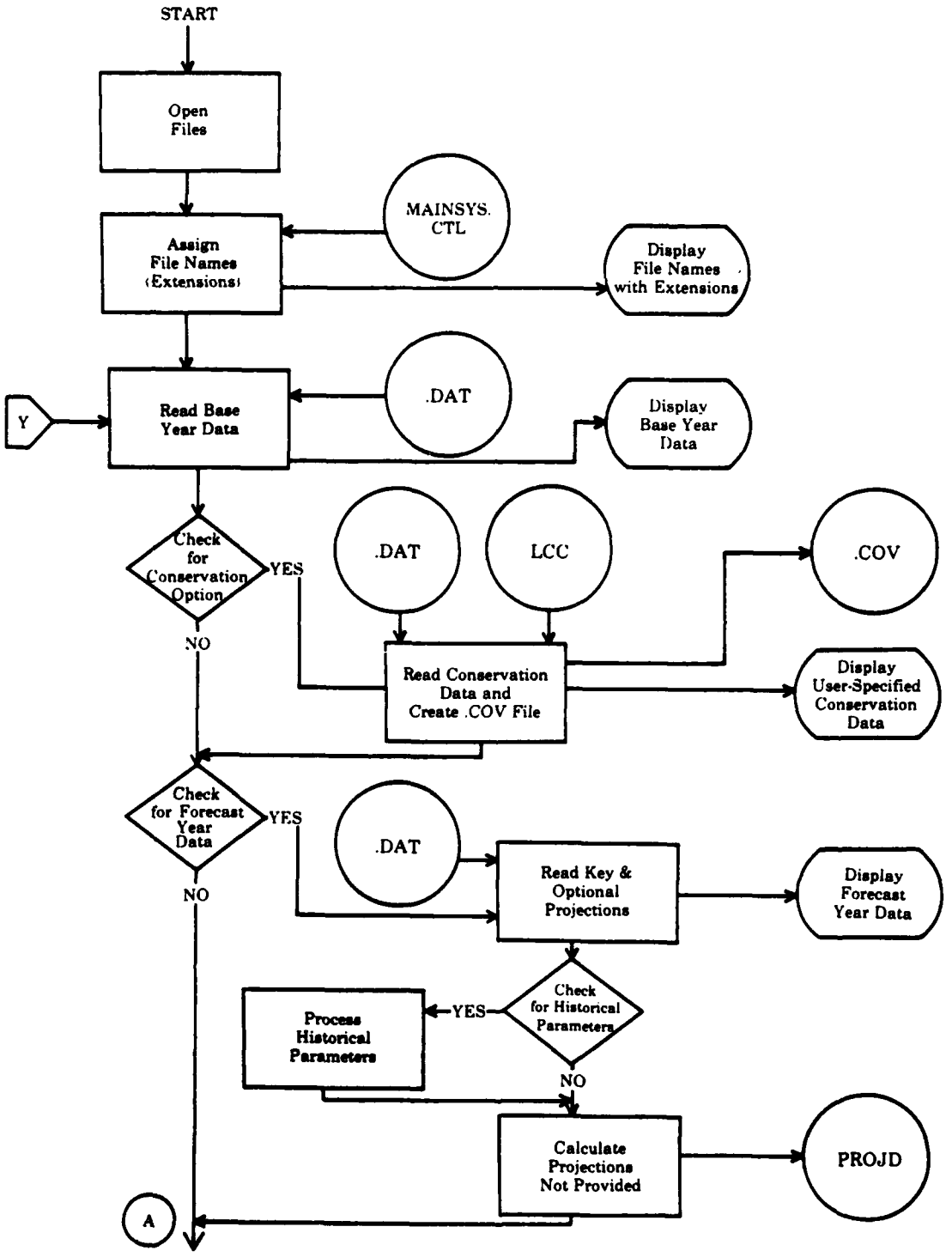
SIMPLIFIED FLOW CHART OF THE EDIT/VALIDATE PROCEDURE

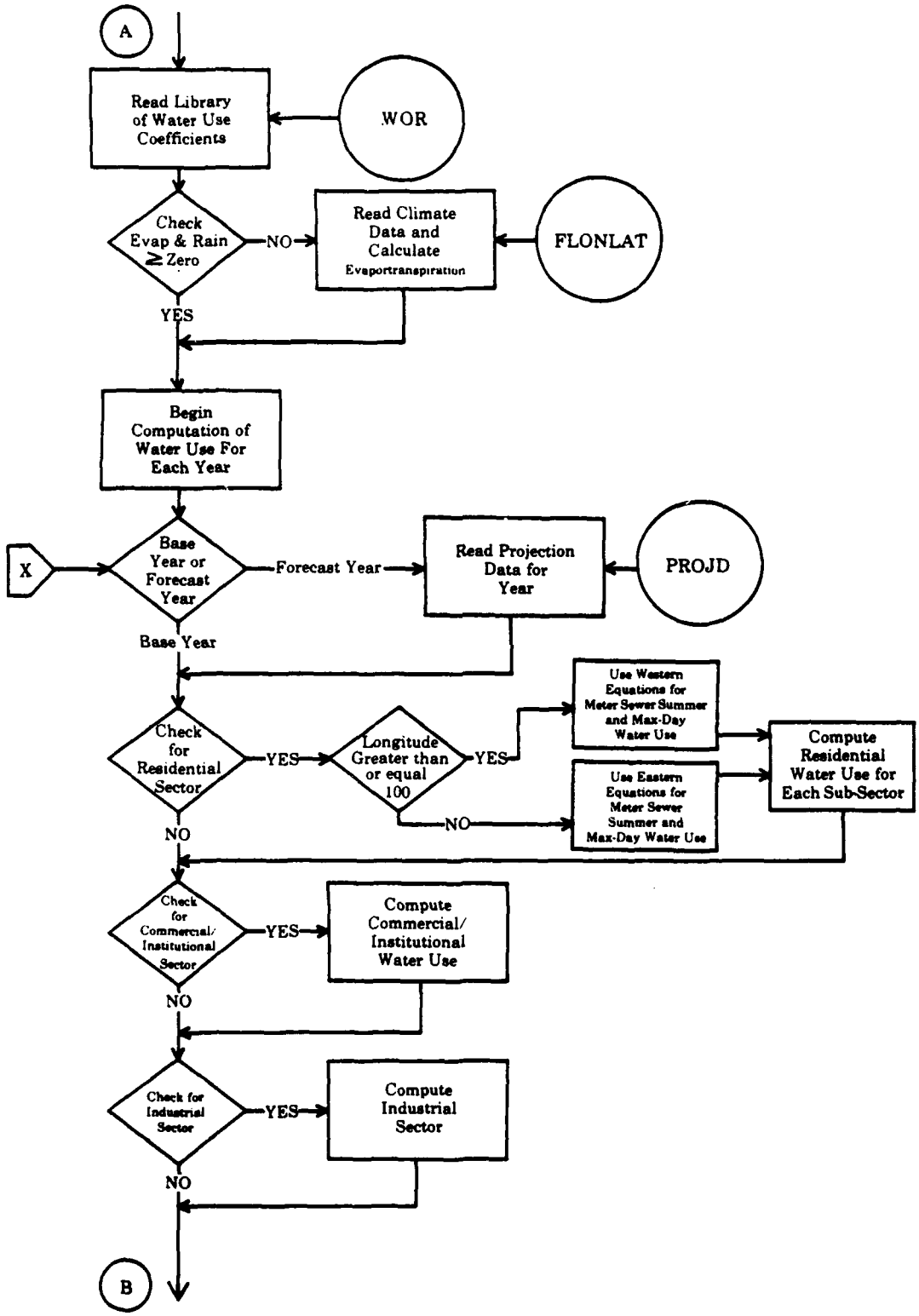


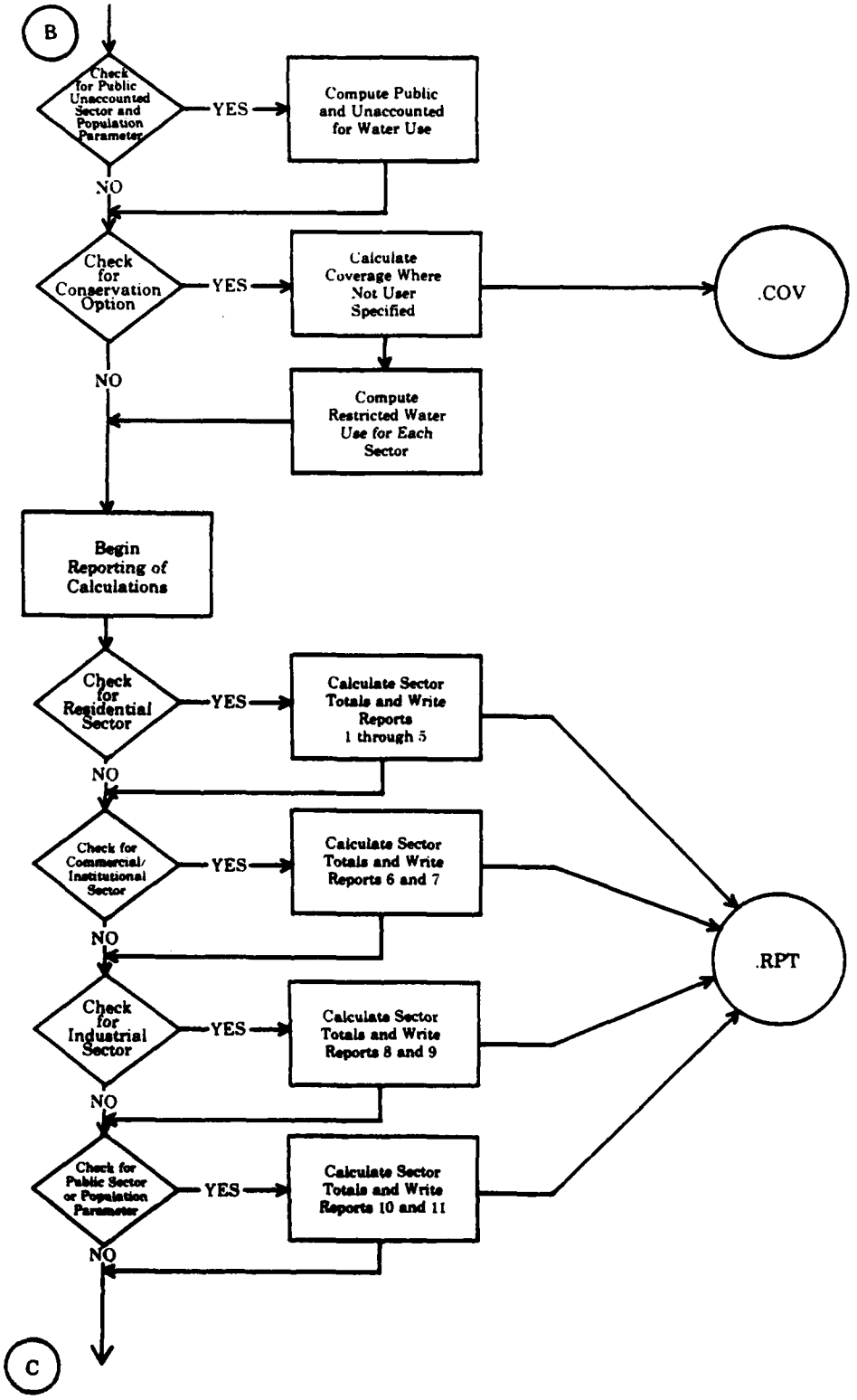
SIMPLIFIED FLOW CHART OF RUN MODEL PROCEDURE

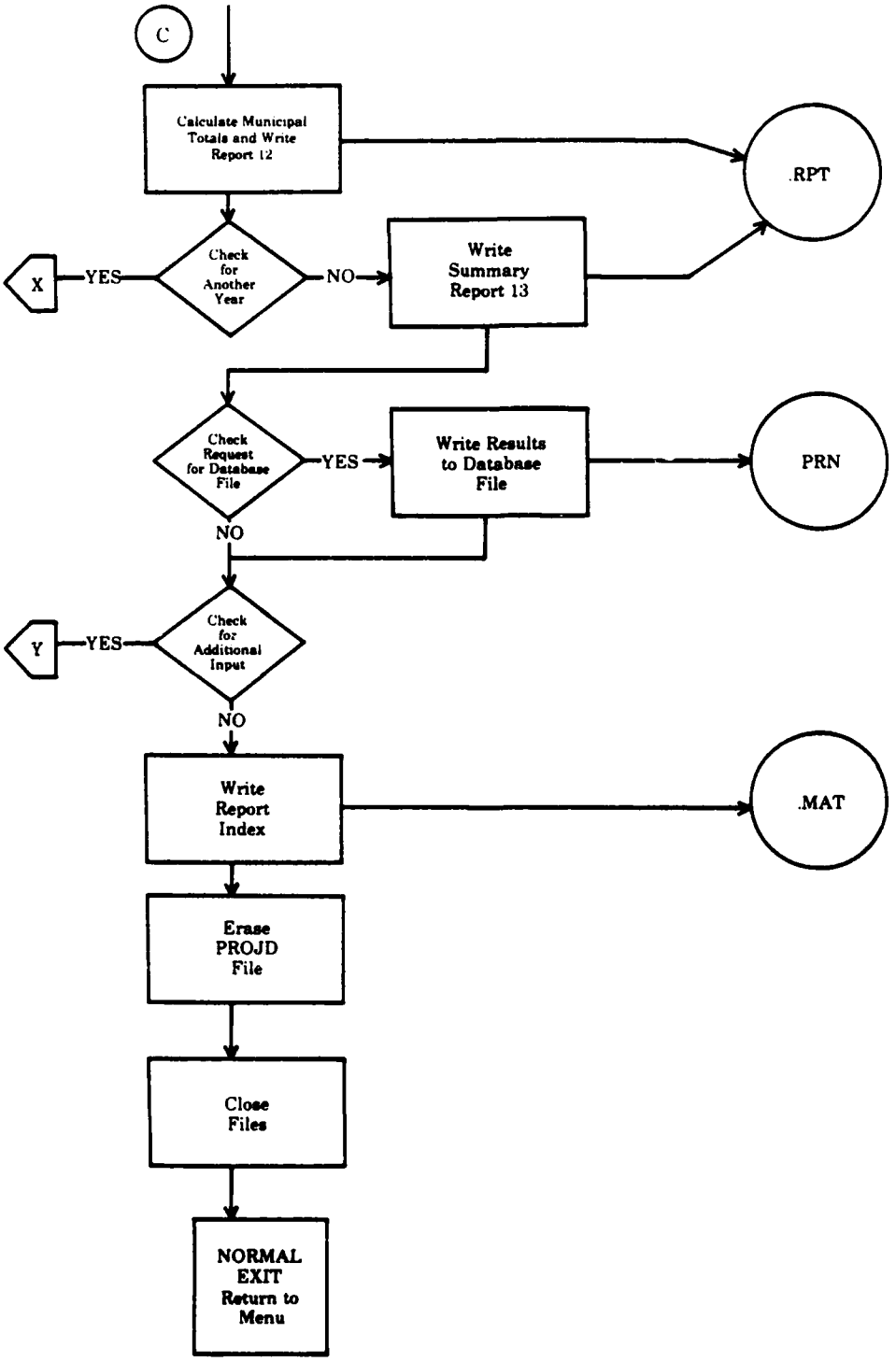


FLOW CHART OF THE RUN MODEL PROCEDURE




A
Read Library of Water Use Coefficients
WOR
Check Evap & Rain ≥ Zero
NO
Read Climate Data and Calculate Evaportranspiration
FLONLAT
YES
Begin Computation of Water Use For Each Year
X
Base Year or Forecast Year
Forecast Year
Read Projection Data for Year
PROJD
Base Year
Check for Residential Sector
YES
Longitude Greater than or equal 100
YES
Use Western Equations for Meter Sewer Summer and Max-Day Water Use
Use Eastern Equations for Meter Sewer Summer and Max-Day Water Use
NO
Compute Residential Water Use for Each Sub-Sector
NO
Check for Commercial/ Institutional Sector
YES
Compute Commercial/ Institutional Water Use
NO
Check for Industrial Sector
YES
Compute Industrial Sector
NO
B


B
Check for Public Unaccounted Sector and Population Parameter
YES
Compute Public and Unaccounted for Water Use
NO
Check for Conservation Option
YES
Calculate Coverage Where Not User Specified
.COV
NO
Compute Restricted Water Use for Each Sector
Begin Reporting of Calculations
Check for Residential Sector
YES
Calculate Sector Totals and Write Reports 1 through 5
NO
Check for Commercial/ Institutional Sector
YES
Calculate Sector Totals and Write Reports 6 and 7
NO
Check for Industrial Sector
YES
Calculate Sector Totals and Write Reports 8 and 9
NO
Check for Public Sector or Population Parameter
YES
Calculate Sector Totals and Write Reports 10 and 11
NO
.RPT
C


C
Calculate Municipal Totals and Write Report 12
.RPT
X
YES
Check for Another Year
NO
Write Summary Report 13
Check Request for Database File
YES
Write Results to Database File
PRN
NO
Y
YES
Check for Additional Input
NO
Write Report Index
.MAT
Erase PROJD File
Close Files
NORMAL EXIT Return to Menu

APPENDIX D

GUIDELINE FOR MAINFRAME COMPUTER USE OF THE IWR-MAIN SYSTEM

GUIDELINE FOR MAINFRAME COMPUTER USE

The IWR-MAIN Water Use Forecasting System operated primarily on mainframe computers until the development of version 3.2. Versions 4.0 and 5.0 of IWR-MAIN were adapted for mainframe use after being developed for PC use. Version 5.1 has not yet been adapted for mainframe use. The following is a brief guideline for the mainframe use of IWR-MAIN; however, due to differences in compilers used on individual mainframe systems, this guideline does not address the adaptation of IWR-MAIN to any specific computer system. Similar guidelines would apply to version 5.1, although the new version generates a variable number of .RPx files.

The PC version of IWR-MAIN contains the file MAIN51.EXE which consists of 10 FORTRAN modules compiled for use on IBM-compatible personal computers using a FORTRAN-77 compiler. Nine of these FORTRAN modules are required for use on the mainframe. (The other module controls the writing of the output to the .RPT file and the creation of the .MAT file.) These modules are:

MAIN51	CALCSUB
REDINP	DISPSUB
REDCOF	UTILSUB
GROWSUB	CONSER
GROWTH	

The FORTRAN source codes for these modules are available from the U.S. Army Corps of Engineers, Institute for Water Resources, Casey Building, Fort Belvoir, Virginia 22060, (703) 355-2217. Once loaded on the mainframe, the source code files for these modules are merged into one file with the MAIN51 module first. The sequence of the other modules after MAIN51 is not important. This merged MAIN51 must then be compiled with a FORTRAN-77 compiler to produce an executable module named MAIN51. Modifications within the source code may be necessary in order to achieve compatibility with the specific compiler being used.

In addition to the executable MAIN51 module, the three library files (COFLB51, FLONLAT, and LCC) are needed and may be uploaded directly from the diskettes of the PC version. The file COFLB51 should be renamed COEFLIB. One additional file needed for the execution of IWR-MAIN is an input data file. This file may be created on the mainframe using a text editor; however, the format of the file must exactly follow that of the .DAT file produced by the Edit/Validate procedure of the PC version. Therefore, the PC version of IWR-MAIN is recommended for inputting data and creation of the .DAT file which can then be renamed as DATA and uploaded to the mainframe. If later changes are desired within the input data file, these changes can be made on the mainframe using a text editor.

Within the MAIN51 source code module, the AFNAME subroutine is provided to assign MS-DOS filename extensions that correspond to the data file, the library files, and the control file, as well as the output file generated by the program. The input/output units assigned to these files and the extensions used are described in comment statements in approximately lines 25 through 50 of MAIN51. To operate on the mainframe, the statement CALL AFNAME(FILE6,6,2) will need to be "commented out" and definitions of the FILE6 subfiles will need to be inserted.

FILE6(1) = 'COEFLIB'	the COFLIB51 library
FILE6(2) = 'OUTPUT'	the output report
FILE6(3) = 'DATA'	the data input
FILE6(4) = 'DATBASE'	the optional data base output
FILE6(5) = 'INDEX'	the index of the output reports
FILE6(6) = 'COVER'	the conservation coverage factors

The FLONLAT and LCC files are not assigned extensions in the PC version and thus will be opened by the program without modifications. The six subfiles will then need to be defined externally with the corresponding auxiliary file in the file definition statements of the batch file used to execute the program. The following is an example of a CMS batch file used to execute IWR-MAIN.

```
& CONTROL CMS
FI COEFLIB DISK PCMAIN COFLB A (RECFM F LRECL 80 BLOCK 80
FI FLONLAT DISK PCMAIN LONLAT A (RECFM F LRECL 80 BLOCK 80
FI LCC DISK PCMAIN LCC A (RECFM F LRECL 80 BLOCK 80
FI DATA DISK CITY DAT A (RECFM F LRECL 80 BLOCK 80
FI INDEX DISK REPORT INDEX A (RECFM F LRECL 80 BLOCK 80
FI OUTPUT DISK OUTPUT LISTING A (RECFM F LRECL 150 BLOCK 150
FI COVER DISK COVER FACTOR A (RECFM F LRECL 80 BLOCK 80
GLOBAL TXTLIB VFORTLIB VALTLIB CMSLIB
LOAD MAIN51 (NOMAP CLEAR START
```

Note that PCMAIN COFLB A, PCMAIN LONLAT A, PCMAIN LCC A, and CITY DAT A are the names of the files on the external disk along with the MAIN51 EXE A. The output report generated in this example OUTPUT LISTING A (and the report index) may then be viewed with a text editor or sent to a printer.

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REFERENCES

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